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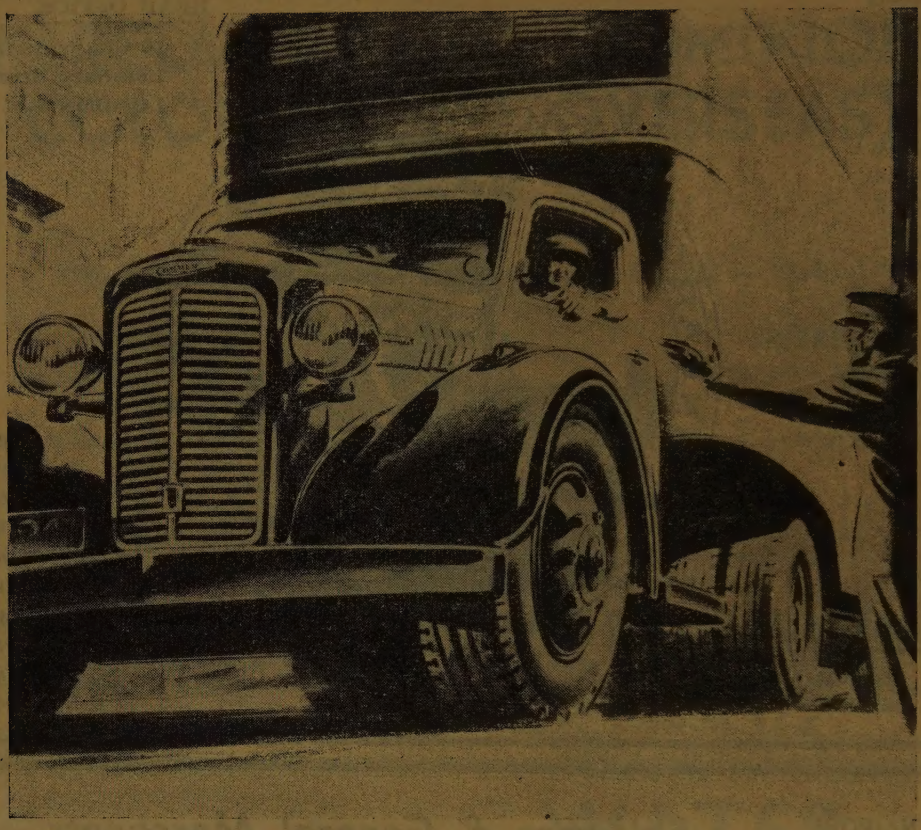

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THE

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Readers are reminded that all agricultural inquiries, whether they relate to articles in the *Journal* or not, should be addressed to the local Director of Agriculture, and not to Amani.

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THE EAST AFRICAN VETERINARY RESEARCH ORGANIZATION

Elsewhere in this issue is a report of the Technical Session of a Conference of the Standing Veterinary Research Committee of the East African Governors' Conference, held at Kabete in April of this year. With the establishment of the East Africa High Commission the Committee will probably become a sub-committee of the East African Advisory Council for Agriculture, Animal Industry and Forestry. The present seems, therefore, a suitable time to take stock of the past achievements of inter-territorial veterinary research in East Africa and to indicate the broad lines of future research policy.

In June, 1939, the Central Veterinary Research Institute was established at Kabete, following proposals put forward by the then Director of Veterinary Services, Kenya, Mr. Daubney. The Institute was to consist of laboratories at the Veterinary Research Laboratory, Kabete, and the staff envisaged was five research workers—virologist, biochemist, zoologist, protozoologist and a general research worker. Capital expenditure for the provision of houses, conversion of laboratories and purchase of equipment was approved by the Secretary of State and was to be met from Colonial Development Funds and recurrent expenditure was to be met by contributions from each of the East African Governments.

With the advent of war the programme was inevitably curtailed. Only two houses instead of five were built and more than half of the capital grant was returned to the Colonial Development Fund. Research staff in East Africa, as elsewhere, were seconded from their research posts to undertake vital war work and it was with the greatest difficulty that the Institute could acquire any research staff at all. At first a zoologist, then a research worker seconded from Kenya Veterinary Department, and finally in 1945 a chemist seconded from Amani to work on insecticides were recruited to the C.V.R.I. This small staff did valuable work on a number of problems of inter-territorial importance, including pleuro-pneumonia, diseases caused by helminths and the value of new insecticides.

Dr. White was appointed Director of the C.V.R.I. on 1st August, 1947, and arrived at Kabete at the end of September. In the meantime Mr. W. B. C. Danks had been appointed Assistant Director of the Institute, and thus the continuity of its work was maintained after Mr. Daubney, who had combined the duties of Director of Veterinary Services, Kenya, and Director of the C.V.R.I., had left Kenya for Cairo. At the end of 1947 the staff of the Institute comprised a Director, Assistant Director and three research workers.

At the beginning of 1948 the C.V.R.I., which had now become the East African Veterinary Research Organization, began to take over the preparation of some of the vaccines and sera issued from Kabete, since it had already been decided that the new organization should undertake the work of preparing and issuing those biological products which were of inter-territorial importance. On 1st July of this year E.A.V.R.O. took over all such products, together with the revenue which they produce, leaving Kenya Veterinary Department with one or two vaccines of purely local importance, together with a variety of drugs, reagents and routine analytical procedures which are of importance primarily within Kenya Colony.

The preparation and issue of biological products is a large undertaking and the staff of E.A.V.R.O., at present still quite small, can, as yet, do little else than deal with this work. Before the end of 1948 it is hoped that sufficient professional, technical, clerical and African staff will be available to permit the establishment of a section of biological products which will devote its activities entirely to vaccine production. A new building, designed to accommodate much of the production of biological products, is in course of erection and should be ready for occupation early in 1949. Five houses for European staff have been built this year and all will be occupied by the end of October.

The section of biological products is to be established as a more or less self-contained unit, and an attempt will be made to introduce a costing system so that it will be possible to see how the prices of the various products are related to their cost of production. In order that biological products shall not be produced

at a loss and thus divert funds from the other research activities of E.A.V.R.O., it will be necessary to fix prices at a level which will cover costs of production and allow a small margin for research work on the production of new and improved vaccines.

Some idea of the magnitude of the task can be gathered from production figures for 1947. During this year 20 different vaccines and sera were produced: 19 of them have now been transferred to E.A.V.R.O. Some three million doses of Kabete attenuated goat virus, a million doses of pleuro-pneumonia vaccine, half a million doses of blackquarter vaccine, and over a quarter of a million doses of anthrax vaccine were issued in 1947, together with about half a million doses of other vaccines. Preparation, testing, bottling and packing and the clerical work involved in the issue of these products necessitates a complex organization. Cattle, sheep, goats and horses, as well as large numbers of small laboratory animals, are used in the preparation and testing of the vaccines and a considerable African staff is required for this work.

To turn now to the other research activities of E.A.V.R.O. It is planned to develop at Kabete the Biological Products and Infectious Diseases Research Sections of the Organization. At Muguga the site some six miles from Kabete at which Dr. Keen will establish the headquarters of the East African Agriculture and Forestry Research Organization, E.A.V.R.O. will set up its own administrative headquarters and will carry out research work on animal husbandry and other problems of animal health. It is planned to establish at Muguga a joint animal husbandry section in which E.A.A.F.R.O. and E.A.V.R.O. will work as a combined team. The problems which E.A.V.R.O. will investigate at Muguga will include animal breeding, animal products (milk, meat, butter, ghee, hides and skins), physiology and biochemistry, and nutrition.

E.A.V.R.O. will thus have two main centres of research in Kenya—biological products and infectious diseases research at Kabete and animal health research at Muguga. At Kabete the organization will enjoy the benefits of close physical proximity with the staff of the Kenya Veterinary Department. At Kabete, too, there will be established in the near future a Clinical Veterinary School for African veterinary students from Makerere. Approval for the establishment of this school has recently been given and it is hoped that Makerere College will be able to begin construction of buildings within the next year.

For some time it has been suggested that a post-graduate school for veterinarians entering the Colonial Veterinary Service should also be established at Kabete. Final plans for this school are not yet complete, but if carried out, they will mean that E.A.V.R.O. staff will be in a position to offer both Makerere students and European graduates the opportunities of taking part in the activities of the organization and of receiving tuition in specialized subjects from the staff of E.A.V.R.O. as well as from the Department of Veterinary Services.

As Muguga is only a few miles from Kabete, there will be day-to-day contacts between E.A.V.R.O. and E.A.A.F.R.O. staff, which cannot but benefit the research activities of both organizations.

It would be unwise to over-emphasize the establishment of the headquarters of E.A.V.R.O. at Kabete and Muguga, however, because much of the work of the inter-territorial research organizations will be undertaken outside those headquarters, at whatever sites in East Africa are found to be most suitable. At the beginning of 1949, for instance, E.A.V.R.O. proposes to begin a study of bovine tuberculosis in Tanganyika Territory, using a research officer equipped with a mobile laboratory, which will enable him to survey the disease and investigate its characteristics on the spot. It is probable that the survey will be extended later to the other East African territories. The Experimental Station at Naivasha, where Dr. Anderson has carried out much valuable work on artificial insemination and disorders of reproduction of live stock, will also be a centre at which E.A.V.R.O. staff can work, provided that the facilities at this centre are improved and enlarged by the provision of additional houses and laboratory accommodation. At Entebbe and Mpwapwa there already exist facilities which would enable specialist research staff to work on a variety of problems of animal disease and animal health. There are also other centres at which such facilities already exist or at which they may become available during the next few years. It is likely that a considerable proportion of E.A.V.R.O. staff will work at such out-stations when the organization has recruited to its ranks something like its full complement of some research workers.

At the present time E.A.V.R.O. is undertaking what research work it can with its limited staff and accommodation. The proposed tuberculosis survey, studies on east coast fever, work on the trypanocidal activity and prophylactic value of new drugs, investigations of the new insecticides in cattle and sheep dips, the development of new and improved vaccines—these are the problems on which E.A.V.R.O. is engaged just now. As soon as additional staff are available some of them will be posted to work in other parts of East Africa while the new buildings at Muguga and Kabete are being constructed.

The introduction of the proposed Colonial Research Service, with salaries and status for professional workers based on the Scientific Civil Service in Britain, will do much to make recruitment easier and will enable research workers to transfer from one research organization in the colonies to another without interfering with their professional careers. It will be possible to obtain research staff for a few years to investigate a specific problem in East Africa and for them subsequently to return to Britain or elsewhere to continue their work. Conversely, staff working in East Africa will be able to go to Britain for a year or so to undertake research more easily carried out there than in East Africa, to return later to investigate other problems. There are considerable difficulties in arranging such visits under the existing conditions of service.

The outline which has been given above of the proposed organization of veterinary research in East Africa shows that the object is to cater for any inter-territorial problems which may require investigation. As the major diseases of live stock are subjected to increasing control, so there will be more opportunity of transferring staff to work on animal health and it is probable that within the next 20 years the centre of gravity of veterinary research in East Africa may shift from disease control to the maintenance of health, a movement which is fast taking place in Great Britain. If rinderpest could be eradicated from the African continent, there would be a much greater opportunity to devote attention to other problems. The International Rinderpest Conference, which will be held in Nairobi in October of this year, will doubtless consider whether eradication is feasible and if so, it will probably suggest measures by which it might be achieved. If rinderpest were eradicated, the way would be open for export of meat to Great Britain, provided that sufficient stock could be maintained in East Africa to give a surplus of meat over and above the requirements of the European, Asian and African populations. Unless or until rinderpest is eradicated from East Africa, such export of meat, even if it were available, would be unacceptable unless a guarantee could be given that carcases were free from the virus of rinderpest. To secure evidence on this last point would require considerable investigation and it might well be that E.A.V.R.O. would have to devote some of its efforts to finding the answer.

The next three or four years should see E.A.V.R.O. firmly established at its Kabete and Muguga headquarters and at various other centres in East Africa. The initial five-year plan for its development, with the aid of capital from the Colonial Development Funds and recurrent expenditure derived from grants from the C.D.F., from the East African Governments and from revenue from the sale of biological products, should see the organization well established and able to make a significant contribution to veterinary research.

For the inter-territorial research organizations to achieve success in their work the closest co-operation between members of the staff of those organizations and of the various East African Government departments is essential. The specialist research worker and the field officer must work together and this co-operation must extend throughout the whole field of inter-territorial and territorial research. The East African Advisory Council, a body on which both territorial and inter-territorial interests will be represented, should do much to bring about this co-operation. So far as the veterinary departments in East Africa are concerned, the experience of the past year suggests that the closest liaison and co-operation will be maintained. Each department has rendered every possible assistance to E.A.V.R.O. in launching it at the beginning of its career. To the Kenya Veterinary Department, in particular, our thanks are due for their continued help in enabling E.A.V.R.O. to begin its work without having to await the construction of new buildings. Houses, laboratories, staff and equipment have been freely put at the disposal of E.A.V.R.O., even when this has involved inconvenience to the Kenya staff at Kabete.

E.G.W.

VETERINARY RESEARCH IN EAST AND CENTRAL AFRICA

Proceedings of the Standing Veterinary Research Committee Conference: Technical Session

Kabete, 29th April–1st May, 1948

INTRODUCTION

The conference of the Standing Veterinary Research Committee of the East African territories held at Kabete Veterinary Research Laboratory from 29th April to 1st May was the last conference of this committee because of the proposed establishment towards the end of 1948 of an East African Advisory Council for Agriculture, Animal Industry and Forestry, which will take over the functions of the various Standing Research Committees.

The Standing Veterinary Research Committee, since its formation in 1936, has been of the greatest benefit to veterinary research in East Africa by bringing together representatives from the four East African territories, as well as delegates from farther afield—the Rhodesias, Nyasaland, Somaliland, the Sudan and Ethiopia—and discussing methods for the control of the major diseases of stock and formulating programmes for research. It is good to know that the new Advisory Council will carry on the work of the various Standing Research Committees.

PRESENT

East Africa High Commission—
- Sir George Sandford, K.B.E., C.M.G., Administrator (*Chairman*).
- Dr. E. B. Worthington, Scientific Secretary (*Vice-chairman*).
- Dr. E. G. White, Director, East African Veterinary Research Organization.
- Mr. W. B. C. Danks, Assistant Director, East African Veterinary Research Organization.
- Dr. B. A. Keen, F.R.S., Director, East African Agricultural and Forestry Research Organization.

Kenya—
- Mr. E. Beaumont, Director, Veterinary Services.
- Dr. S. E. Piercy, Veterinary Research Officer, i/c Research, Kabete.
- Dr. E. A. Lewis, Chief Field Entomologist.
- Capt. A. T. A. Ritchie, O.B.E., M.C., Game Warden.
- Dr. S. F. Barnett, Veterinary Research Officer, Kabete (*Secretary*).

Tanganyika—
- Mr. N. R. Reid, M.B.E., Ag. Member for Agriculture and Director of Veterinary Services.
- Mr. J. K. Wilde, Chief Veterinary Research Officer.

Uganda—
- Mr. W. L. S. Mackintosh, C.B.E., Director of Veterinary Services.
- Mr. H. Cronly, Deputy Director of Veterinary Services.
- Dr. S. G. Wilson, Senior Veterinary Research Officer.

Zanzibar—
- Mr. R. Alley, Veterinary Officer.

Nyasaland—
- Mr. D. F. Macpherson, Director of Veterinary Services.

Northern Rhodesia—
- Mr. J. H. N. Hobday, O.B.E., Director of Veterinary Services.
- Mr. J. W. Macaulay, Senior Veterinary Research Officer.

Southern Rhodesia—
- Mr. D. A. Lawrence, Director of Veterinary Research.

Somalia—
- Major R. G. Pearson, Senior Veterinary Officer.

U.N.F.A.O. (Ethiopia)—
- Dr. R. C. Reisinger.

In Attendance for Certain Items—
- Dr. R. R. Le Geyt Worsley, East African Veterinary Research Organization.
- Mr. R. N. W. T. Fiennes, East African Veterinary Research Organization.

PROCEEDINGS OF TECHNICAL SESSION

Chairman of Technical Session: Dr. E. B. Worthington, Scientific Secretary, East Africa High Commission.

Agenda

1. Rinderpest.
   - (*a*) Review of present position in East Africa.
   - (*b*) Progress in methods of immunization.
   - (*c*) Persistence of Kabete Attenuated Goat (K.A.G.) virus and natural virus in live cattle and in meat carcases in relation to a possible export trade.

(*d*) International Rinderpest Conference in Nairobi in October, 1948.

2. Foot-and-mouth Disease.
3. East Coast Fever.
   (*a*) Research work in East Africa.
   (*b*) Control in native areas.
   (*c*) The value of Gammexane dips.
4. Trypanosomiasis.
   (*a*) Trypanocidal drugs.
   (*b*) Insecticides and repellants against *Glossina*.
   (*c*) Mechanical transmission.
   (*d*) Transmission by *G. palpalis*.
   (*e*) General progress in control of the disease.
5. Wild fauna in relation to the live stock industry.
6. Tuberculosis.
7. Other problems of Animal Disease and Animal Health in East Africa.
   (*a*) "Lumpy skin disease".
   (*b*) Pleuro-pneumonia.
   (*c*) *Corynebacterium ovis* infection in sheep.
   (*d*) Bovine sterility.

1—Rinderpest

(a) Review of present position in East Africa

Mr. Beaumont reported that the incidence of the disease was the lowest on record in Kenya Colony. There had been three outbreaks in the Masai Reserve and one outbreak in transit cattle at the Coast. Mr. Reid said that in Tanganyika the position during 1947 had been fairly satisfactory. Several outbreaks had occurred but they were mainly confined to the Lake and Northern Provinces. Mr. Mackintosh said in Uganda the position had been good. There had been one outbreak in the north of the Protectorate which had developed from the enzootic area of Karamoja, an area which was thought to extend into the Turkana District of Kenya and which presented difficulties so far as control was concerned because of insufficient veterinary staff. He stated that he had been forced to quarantine the infected area and to immunize cattle in the surrounding country every two years.

Conclusion

It was noted that 1947 had been a satisfactory year from the point of view of the small number and extent of outbreaks. It is of primary importance that staff and facilities are made available at an early date to enable Uganda and Kenya to extend their rinderpest immunization to the northern areas of their territories, and that rinderpest control should be strengthened in the adjoining territories to the north by the Governments concerned.

(b) Progress in methods of immunization

The views of the various Departments of Veterinary Services were expressed regarding the best methods of immunization. Whereas Kenya and Uganda preferred to use Kabete Attenuated Goat (K.A.G.) virus to suppress outbreaks and to protect neighbouring cattle, Tanganyika used triple inoculation with formolized spleen vaccine to suppress outbreaks and restricted the use of K.A.G. to protective inoculation of neighbouring herds.

It was generally agreed that K.A.G. virus did not give a satisfactory immunity in calves and that further work on calfhood immunity in rinderpest was required.

The high susceptibility of Ankole cattle and of Zebu cattle west of the Nile was a serious problem, and it was hoped that egg-vaccine or some other vaccine more attenuated than K.A.G. would be developed for use in these cattle.

Mr. Danks mentioned difficulties encountered in research on egg-vaccine, particularly the ease with which strains of virus were lost on continued passage through developing eggs. He mentioned that work was now in progress on a rabbit-adapted rinderpest virus (lapinized virus) which had recently been sent to Kabete from China by Dr. H. S. Purchase.

Conclusion

It was urged that the highest priority be given to research into virus diseases in general and their control, in the first instance with particular reference to rinderpest and foot-and-mouth disease. Recruitment of suitable staff for this work is of the utmost urgency.

The priorities in work on rinderpest are:—

(1) *Persistence of rinderpest and K.A.G. virus in carcases.*
(2) *The development of a vaccine suitable for the more highly susceptible cattle, e.g. Ankole cattle.*
(3) *Work on conferring a durable immunity in calves.*

(c) Persistence of Kabete Attenuated Goat virus and natural virus in live cattle and in meat carcases in relation to a possible export trade

The possible export of meat to the United Kingdom from East Africa was discussed in the light of representations from the Ministry of Agriculture in Great Britain that an assurance would be required that such carcases

would not contain the virus of rinderpest. The Ministry of Agriculture would have to be assured on two points: (1) that animals recovered from natural rinderpest do not harbour the virus; (2) that cattle immunized with K.A.G. living modified virus do not carry the virus.

Mr. Beaumont stated that the whole basis of rinderpest control in East Africa for many years had rested on the assumption that in neither case was virus present. There was general agreement among the delegates with this view, but it was stressed that experiments would have to be carried out to establish beyond doubt the facts of the case and a sub-committee of the conference was appointed to consider what steps should be taken to carry out such experiments.

Conclusion

It was recommended that at the request of His Majesty's Government the investigation on the persistence of rinderpest virus in carcases be devoted to:—

(1) *Cattle recovered from natural infection.*
(2) *Cattle recovered from a reaction to K.A.G. virus.*
(3) *The distribution of virus in cattle in the incubative stages of natural rinderpest.*

It was recommended that highly susceptible cattle be used in the transmission experiments.

(d) International Rinderpest Conference in Nairobi in October, 1948

The Chairman drew the attention of delegates to this conference, to be held in Nairobi in October, 1948, and asked for contributions from Directors of Veterinary Services giving their views as to the present position and methods for eradicating the disease.

Conclusion

Directors of Veterinary Services undertook to prepare short notes on the rinderpest problem as applying to their territories by the end of June, 1948. *These would be collated by the East African Veterinary Research Organization into one statement covering the whole East Africa region.*

2—Foot-and-mouth Disease

Dr. White referred to the economic importance of the disease on European farms and to the difficulties of producing effective vaccines. Vaccine as prepared in various European countries was very expensive and had not been satisfactorily tested. He was awaiting the arrival of an officer who had just spent some time at the Foot-and-mouth Disease Research Station in Britain and who had also visited some European countries to study vaccine production there. As soon as staff conditions permitted it was hoped that the East African Veterinary Research Organization would study vaccine production in Kenya. The difficulties involved were many and they included the problem of acquiring sufficient susceptible cattle for experimental purposes, the varying strains of virus in East Africa, and the expense of vaccines as at present prepared in other countries.

Delegates from the various territories expressed interest in the proposed work, and Mr. Hobday mentioned that he intended to investigate the value of a vaccine prepared in the field from natural outbreaks in Northern Rhodesia.

In addition to its use on European farms, delegates agreed that a vaccine might be of value on stock routes.

Dr. White stated that work on the production of a vaccine would begin as soon as staff and facilities at Kabete were available.

Conclusion

The conference noted that a new member of the staff of the East African Veterinary Research Organization, Mr. Brotherston, who had experience in foot-and-mouth disease, was expected in East Africa shortly. It was recommended that special attention in this work should be devoted to methods of producing vaccines in the field from material derived from local outbreaks of the disease.

3—East Coast Fever

(a) Research work in East Africa

Dr. Wilson outlined some recent work carried out in Uganda. Field observations made by him in Nyasaland had indicated a relation between the incidence and severity of the disease and the incidence of ticks. Preliminary work at Entebbe had shown that the percentage mortality appeared to be reduced when the tick population was low. Susceptible animals exposed in paddocks to a low tick population were shown subsequently to be immune. He was also experimenting on the feeding of small numbers of infected ticks on susceptible cattle.

Other delegates stressed the need for systematic research on infections caused by species of *Theileria* as a whole since other *Theileria* than *T. parva* were probably of importance, particularly in causing confusion with true East Coast fever.

Dr. Lewis mentioned that work at Kabete had shown the importance of the age of infected ticks in affecting the severity of East Coast fever: the older the tick, the milder was the disease which resulted, and ticks infected twelve months previously were no longer infective.

The Chairman appointed a sub-committee to discuss the whole problem of research work on *Theileria* and to suggest lines of future research.

Conclusion

It was recommended that work on Theileria parva *and related* Theileria *spp. should be undertaken and should be given priority over work on the other tick-borne diseases. The following problems require detailed attention:—*

(1) *The relationship of* T. parva *to other* Theileria *species.*

(2) *The reactions in cattle to* Theileria *infections including individual susceptibility of cattle, changes of pathogenicity of* Theileria *in the tick host, and the production of immunity in cattle.*

(3) *The ecology of the East Coast fever tick vectors.*

(b) Control in native areas

Mr. Cronly described the great reduction in calf mortality in parts of Uganda which had followed the improvement in animal husbandry among native stockowners. In the past, with communal herds tended by hired herdsmen, calf mortality had been 40–50 per cent and most of the deaths were attributed to East Coast fever. To-day the herds were kept on the smallholding, they were looked after by their owners and their staff, they were well fed and managed, and they were housed during the heat of the day in sheds with smudge fires to protect them from biting flies. Calf mortality had fallen to 10 per cent or less, although the tick population was still high.

Other delegates pointed out that the previous high mortality had not been proved to be due to East Coast fever and the improvement might be attributed to the effects of better husbandry and nutrition in preventing the great variety of other diseases to which calves succumbed. Mr. Cronly explained that the calves could be moved to known East Coast fever areas without succumbing to the disease and would thus appear to have acquired an immunity. He was thus fairly certain that it was in fact East Coast fever which had caused most of the high mortality in the past.

Discussion then centred on the control of East Coast fever in native areas by dipping. The efficacy of dipping in native areas depended on the place and on the tribes concerned. Tanganyika was adopting wholesale dipping in two areas, stated Mr. Reid, and by this means it was hoped to control not only East Coast fever but also other tick-borne as well as skin diseases.

Mr. Lawrence said that dipping had proved very effective in Southern Rhodesia. The normal dipping interval was seven days, but this was extended in cold, dry weather to fourteen days or even longer because of lack of water and difficulty in mustering the cattle. Five-day dipping, possibly combined with effective hand-dressing, might be required in seasons when tick infestation was particularly heavy.

The Chairman invited the Directors of Veterinary Services to meet to consider results to date and to frame a policy for the control of East Coast fever in native areas.

Conclusion

The conference was not in a position to recommend an alternative to dipping for the control of East Coast fever, but suggested that investigations into other methods of tick control were urgently required.

(c) The value of Gammexane dips

Mr. Wilde reported on the use at Mpwapwa of a half-bath in which the animals were submerged only up to the dewlap, and the head and perineum were treated by spraying or washing. The half-bath required less dip, and was less expensive to construct and would possibly be of value in native areas. He had used "Gamatox" at a rate of 1 lb. per 100 gallons, representing 45–50 p.p.m. B.H.C. (Benzenehexachloride). The tick species present in the area were *Rhipicephalus appendiculatus, R. evertsi* and *Amblyomma variegatum.* Dipping was carried out on a group of ten cattle for a period of eight months, using seven-day dipping at first and four–five–four-day dipping towards the end of the period.

Tick counts fell from an initial total count of 600 nymphs to about two after dipping: other tick stages were reduced to similar proportions. The ears were least affected and this he attributed to the presence of grease preventing penetration of the gammexane. An oily dressing or a power spray would probably be preferable. The dip fluid was frequently made up to strength and the final concentration

was 64 p.p.m. B.H.C. The "tickicidal" properties of the fluid remained effective throughout the duration of the experiment.

Mr. Wilde said that although the half-bath represented an economy in dipping fluid and initial cost of construction, he had nevertheless come to the conclusion that total immersion was preferable.

Dr. Worsley said that experimental work on gammexane dips at Kabete had not been started because the new dip was not yet ready for use. He had, however, received full co-operation from a number of farmers who had agreed to keep reliable records of the animals dipped and of the concentration of the dip and its renewal. Results with "gamatox" were unsatisfactory. The dips showed a continual progressive loss of strength and most of the analyses showed a concentration of B.H.C. representing 50–100 per cent below strength. Making up the volume of the dip with "Gamatox" had not maintained the efficacy of the dip and he attributed this mainly to the removal of B.H.C. by the animals, leaving behind a fluid of progressively lower concentration and effectiveness. Calculations had shown that the fluid removed from the dip by animals passing through it had caused reduction in the concentration of B.H.C. and this view was supported by analysis of the fluid draining from the animals' coats which contained only 1:1,500 gammexane whereas the dip fluid contained 1:600 gammexane. These results suggested a continual loss of B.H.C. by removal on the animals' coats, and if this were true it would necessitate adding more concentrate to the dip in proportion to the number of animals passing through it.

Mr. Lawrence reported on the use of B.H.C. dips in Southern Rhodesia. The dips had been found very effective when first used, but within three months it was found that the concentration and effectiveness were reduced and most farmers had now reverted to arsenic dips. He gathered that a similar unsatisfactory state of affairs existed in South Africa. Arsenic and nicotine sulphate were being used in blue tick areas or, where B.H.C. dips were used they were renewed every few months. It had also been found that the effectiveness of B.H.C. dips fell off in spite of a high content of B.H.C. and he thought that there must be some loss of the gamma isomer.

Dr. Wilson stated that in Uganda the results with B.H.C. dips had also been disappointing, the effectiveness falling off after two to three months. The good results reported by Mr. Wilde at Mpwapwa were probably due to the frequent renewal of the dipping fluid because of the small volume of the half-bath. Experiments were in progress in Uganda with crushes, half-baths and dipping tanks, and he was obtaining in the near future a supply of an oily dressing and a special gun for spraying the ears and perineum.

Dr. Worsley mentioned a few observations on farms where a new proprietary B.H.C. dip, "Zondagam", had been used. The observations had continued over a period of only two-and-a-half months and so far there had been no reduction in effectiveness.

The Chairman appointed a sub-committee to discuss the problem of gammexane dips and to suggest lines for future investigation.

Conclusion

From the reports received from various territories the conference concluded that further research is necessary before proprietary preparations relying for their efficacy on B.H.C. can be recommended for general field use.

4—TRYPANOSOMIASIS

(a) Trypanocidal drugs

Mr. Fiennes reported the results of trials with phenanthridinium 1553 which had been planned at the 1947 Conference of the Committee. Very satisfactory results had been obtained in Kenya with doses of 1.5 mgm. per kg. bodyweight and similar results had been reported from Northern Rhodesia. In Uganda there had been two cases of delayed toxicity, with photosensitization. The drug was now issued for routine use in Kenya in the form of a dry powder to which the required amount of water was added to give a three per cent solution for injection intramuscularly. The drug cost only fifty cents a dose.

Mr. Wilde reported very good results from trials in Tanganyika. No relapses occurred in fifty-seven cattle treated. Considerable local swelling occurred after subcutaneous inoculation. One case of photosensitization occurred. He mentioned the development of skin lesions in one herd of cattle treated with the drug but considered that the reaction was due to some factor other than the drug because only animals at or just before calving were affected. A toxic plant causing photosensitization was a possible explanation.

In Northern Rhodesia the drug had proved 100 per cent effective, according to the results reported by Mr. Hobday. Retreatment of herds caused no ill-effect.

Mr. Fiennes mentioned a new trypanocidal drug which the chemists of Imperial Chemical Industries had produced and which was being tried out in Kenya and Uganda and in the Sudan. The experimental work was being carried out by scientists and technicians sent to Africa by Imperial Chemical (Pharmaceuticals), Ltd., working in consultation with members of the staff of the various research stations.

Conclusion

Replicated trials in the use of phenanthridinium compounds 897 *and* 1553 *arranged at the meeting in February,* 1947, *were noted. These drugs had in general given very satisfactory results. Certain toxic effects reported to follow upon administration of* 1553 *did not occur consistently and further investigation was desirable in those countries where these effects have been observed. A new drug prepared by Imperial Chemical (Pharmaceuticals), Ltd., was now being tried out in East Africa and the Sudan.*

(*b*) *Insecticides and repellants against* Glossina

The Chairman informed the meeting that the Colonial Insecticides Committee had arranged for trials with air spraying or smoking against *Glossina* to commence in 1948. These trials would in the first place be based on Entebbe, Uganda, and later trials would be undertaken in Tanganyika Territory, where the unit was likely to be based on Kondoa. Further trials might be arranged elsewhere, directed against agricultural pests as well as tsetse flies.

Dr. Lewis outlined the importance of the mechanical carriage of tsetse flies by trains and lorries.

Conclusion

The conference noted the provisional programme for trials of the application of insecticides from the air, to be undertaken by the Colonial Insecticides Committee in East Africa during 1948 *and* 1949.

The problem of controlling tsetse flies carried by trains was noted and Dr. Lewis undertook to circulate his report on this subject to all veterinary departments and others concerned.

(*c*) *Mechanical Transmission*

Dr. Lewis mentioned that several outbreaks of sudden and severe trypanosomiasis had been brought to his notice in which mechanical transmission had apparently played a part, although it was nearly always difficult to exclude the possibility that *Glossina* had initiated the infection.

The Chairman mentioned that at the Brazzaville Conference on Trypanosomiasis mechanical transmission was stated to be of importance in the Sudan. An instance of presumed mechanical transmission was quoted by Mr. Hobday in which the disease followed the introduction of infected cattle into a herd situated some eighty miles from the nearest known *Glossina* infected area.

The conference agreed that further information was required as to the exact part played by mechanical transmission: the fact that infected trade stock moved long distances without apparent spread of the disease was against the view that this form of transmission was important or common. It seemed likely that in many instances occasional *Glossina* caused the initial cases of disease and it might be possible for biting flies present in large numbers to spread the infection in a herd.

Conclusion

It was considered that further investigation is required on this problem.

(*d*) *Transmission by* Glossina palpalis

Dr. Lewis told the meeting that *G. palpalis* could transmit *Trypanosoma vivax* readily and that a high proportion of flies in the Nyanza Province were infected. The strain of *T. vivax* found in the Nyanza Province caused a mild or chronic form of disease when transmitted by *G. palpalis,* whereas a strain of *T. vivax* obtained from the Central Province produced a hyperacute disease when transmitted by *G. pallidipes.* When transmitted serially by *G. palpalis* the same virulent strain of *T. vivax* gave rise to a mild or chronic disease. It seemed, therefore, that the virulence of *T. vivax* could be modified by passage through *G. palpalis.*

In reply to a question by Mr. Cronly, Dr. Lewis stated that he would recommend clearing of areas with *G. palpalis,* because although the disease transmitted by this fly was chronic, it did result in emaciation and ultimate death. Mr. Reid stated that a recent outbreak of trypanosomiasis in Tanganyika had been traced to *T. vivax* transmitted by *G. pallidipes.*

Conclusion

It was considered that further investigation is required on these problems,

(e) General progress in control of the disease

Mr. Fiennes outlined his previous work in Uganda and at Kabete on immunity in trypanosomiasis, and suggested the possibility of raising the resistance of cattle by producing recovery from natural infections by sub-curative doses of trypanocidal drugs. There was evidence that some degree of immunity to trypanosomiasis could be built up in cattle.

Mr. Lawrence thought it would be dangerous to try to build up immunity which might prove to be only partial because by so doing one might build up a reservoir of infected animals which might constitute a danger. He believed that chemoprophylaxis afforded the only hope of ultimate control.

Conclusion

The conference took note of investigations being undertaken by Mr. Fiennes on premunity and immunity and considered that work on these aspects should figure in the future programme of research in animal trypanosomiasis.

5—Wild Fauna in Relation to the Live Stock Industry

The conference discussed the resolutions of the Fauna Conference held in Nairobi in May, 1947.

Mr. Reid said that game preservation and human habitation could not be combined in the same area, and urged that human beings be excluded from areas in which game were protected. In his opinion, game were more important in the transmission of disease to stock than any other single factor. He would like a reasoned statement from veterinary and animal husbandry authorities concerning the part played by wild fauna in the transmission of disease.

Capt. Ritchie said that such a statement would be difficult to compile as much research into published work and unpublished records would be required. He agreed that such a statement would be of the greatest value.

The conference recommended, in reference to a suggestion from Mr. Reid, that funds for experimental fencing of game areas should be made available.

Other points mentioned were the need for consultation with veterinary authorities before sites for game parks or reserves were selected, and the danger of using rivers to act as boundaries of game reserves because of transmission of disease from game to stock at a watering site common to both.

Conclusion

The conference considered the resolutions of the Fauna Conference held in Nairobi in May, 1947. The resolutions were approved in general, but, recognizing that transmission of diseases by wild fauna causes more difficulty in the control of certain diseases than any other factor, the conference recommended that:

(1) *Governments should aim at the exclusion of domestic stock from national parks.*

(2) *Governments should take more definite action to control fauna in stock areas.*

(3) *A statement should be prepared under the direction of the East African Veterinary Research Organization concerning the general problem of wild fauna as it affects the live stock industry, with a critical assessment of the evidence available.*

(4) *Funds should be made available for experimental fencing to control movements of fauna in certain areas.*

(5) *The opinion of Veterinary Departments should be taken into full consideration in siting national parks and other declared game areas.*

(6) *Legislation concerning fauna should be referred to Veterinary Departments wherever it affects stock interests.*

The conference expressed the wish to assist Game Departments and National Park authorities in their work of conservation and control of wild fauna.

6—Tuberculosis

Dr. White put before the conference a report of his visit to the Southern Highlands of Tanganyika where the incidence among cattle of a disease which is apparently tuberculosis is very high. He considered that the problem should be investigated, and suggested that the East African Veterinary Research Organization should obtain the services of an officer who would be posted in Tanganyika to investigate the disease. The work would include tuberculin testing, slaughter and bacteriological and pathological investigations. As a result of the investigation Tanganyika Government might wish to introduce suitable measures for further investigation and control of the disease: the research worker would then turn his attention

to tuberculosis in the other East African territories.

There was some discussion as to whether the problem merited attention at a time when the staff at Kabete was inadequate for other problems, but it was finally agreed that the work in Tanganyika should be undertaken as a matter of urgency, provided that an officer was appointed who would not be more usefully employed to study virus or protozoal diseases. Representatives of Kenya, Tanganyika, Northern Rhodesia and Nyasaland expressed interest in the proposed investigation because each territory was concerned to prevent the import of tuberculous cattle and to do everything possible to reduce the incidence of the disease where it already existed.

Conclusion

The conference recommended that a full investigation on tuberculosis of cattle in East Africa should be started as soon as possible. A special officer would be required for this purpose, and he should be appointed to the staff of the East African Veterinary Research Organization in order to work in the first place with the Department of Veterinary Science and Animal Husbandry in Tanganyika.

7—Other Problems of Animal Disease and Animal Health in East Africa

(a) "Lumpy Skin Disease"

Mr. Reid asked for the opinion of the conference as to the importation of cattle from South Africa in view of the danger of importing this disease. Mr. Lawrence said that Southern Rhodesia was importing stock from South Africa, but such stock came only from areas free of the disease. The disease was scheduled in the Union, and he did not think there was any risk of importing the disease with cattle from clean areas. Mr. Hobday stated that one case had occurred in a beast imported from the Union, but he thought there was little risk if imported animals were quarantined. Both Mr. Reid and Mr. Beaumont, representing Tanganyika and Kenya respectively, were unwilling to accept the risk of introducing the disease into East Africa, and they considered that the existing ban should be retained for the present.

Conclusion

The conference recommended that the existing embargo on the import of cattle from South Africa to East Africa should continue for the time being.

(b) Pleuro-pneumonia

Mr. Hobday described the methods used with success to control the disease when it was introduced into the Barotse Province in 1945. Vaccination was the most important single factor in providing control: the outbreak was stopped in infected herds some six weeks after vaccination, but it was necessary to revaccinate three months later. All the animals in the Province were vaccinated at intervals and he was ruthless in the measures used to control the disease, as he regarded elimination of the infection important enough to justify the occurrence of occasional deaths from the rather virulent vaccine employed.

Mr. Reid also reported favourably on the use of the vaccine from Kabete in an area in Tanganyika with some 250,000 cattle. Mr. Beaumont said he was not entirely satisfied with the results of vaccination in Kenya. Mr. Mackintosh reported that the vaccine had successfully combated the last outbreak in Uganda, and Mr. Reid mentioned as a matter of interest that K.A.G. virus and pleuro-pneumonia vaccine had been given together, without ill-effect.

Conclusion

Reports showed that the use of the Kabete vaccine had given encouraging results in the control of bovine pleuro-pneumonia in several territories, but certain disparities in these results had yet to be explained.

(c) Corynebacterium ovis *infection in sheep*

Mr. Wilde asked whether a toxoid was available for use against this infection because he had encountered losses in sheep which were apparently caused by this organism. Dr. Barnett stated that he was preparing *C. ovis* toxoid but that certain technical difficulties stood in the way of obtaining a standard product in large quantities. He mentioned that the toxoid was used for ulcerative lymphangitis in horses, for which disease it showed some promise of having prophylactic value. He had no experience of its use in sheep.

(d) Bovine sterility

The conference agreed on the need for further research on sterility diseases, particularly epi-vaginitis.

Conclusion

The conference considered that the effects of bovine sterility, particularly those forms due to epi-vaginitis, were of such importance to the cattle industry of East and Central Africa that active research into methods of diagnosis and control should be given high priority.

REVIEW: COLONIAL OFFICE MEMORANDA ON COLONIAL FERTILIZER EXPERIMENTS*

In some colonial territories adequate fertilizer trials on plantation crops are in progress, but the economic difficulties of introducing artificial fertilizers into native peasant farming has hitherto deterred authorities from undertaking extensive fertilizer trials. However, in view of the very great importance of increasing the production of all crops, especially food crops, the Colonial Advisory Council of Agriculture, Animal Health and Forestry has recently recommended that steps should be taken in Colonial territories to carry out fertilizer experiments with different crops on all soil types with the object of obtaining precise information on the response of crops to the different fertilizers and on the economics of application. These two memoranda have been prepared with the object of guiding Colonial Agricultural Departments and Research Institutes on the conduct and technique of fertilizer trials.

Because the modern technique of statistics has not been widely used in field experiments in the Colonies, most of this review is devoted to Dr. Crowther's paper, and I have not hesitated to quote extensively from it. Dr. Stewart's paper covers a wide field and integrates the effect and use of chemical fertilizers with the fundamental principles of agricultural science. Both papers cannot be too highly recommended.

The agriculturist and statistician must work together, and both must compromise. Practical agricultural conditions may make a fully replicated trial in each field impossible, but the agriculturist must realize that certain fundamental requirements have to be met. Soil depth, drainage and permiability, and many other factors help to determine yield, and it is most important to correlate the results of experiments with local variations within major soil types as well as with meteorological observations.

The study of the use of fertilizers to increase the production of organic matter by green manure crops, whether these be legumes or not, may be well worthwhile, but at the same time it must be remembered that organic matter oxidizes and disappears very rapidly from tropical soils and the effect of a green manure crop or a grass ley may, therefore, be very transitory.

The obvious importance of testing locally available materials as fertilizers is stressed, but Dr. Crowther rightly insists that all early experiments in any region must include recognized and well-tried fertilizers. Very misleading conclusions have in the past been drawn from experiments which gave negative responses to a locally-produced ground rock phosphate, which was in fact at a later date shown to be ineffective as a source of phosphorus as compared with superphosphate.

The general principles and practical application of modern statistical theory to field experiments set out in the publications of Fisher and Yates are of necessity detailed and complicated. Furthermore it is generally believed that no useful information can be obtained from factorial experiments unless an expensive calculating machine is available and a great deal of time can be spared for working out heavy computations. It is because of this, I believe, that the practical value of complex or factorial experiments has not hitherto been widely appreciated in Colonial agriculture. Dr. Crowther points out that some of the more recent developments in experiment design are particularly well suited for dealing with the multitude of complicating factors which necessarily enter into "practical" experiments. All the designs recommended in his memorandum will give reliable and unbiased results by simple addition and subtraction, provided that care is taken to tabulate results only for those treatments which are represented in every block of the experiment.

Dr. Crowther further points out what is perhaps not sufficiently well known, namely that even if labour and transport, or other difficulties, make it impossible to obtain the full data from an experiment by harvesting it, nevertheless very valuable information can often be obtained, provided that the experiment was properly designed and laid out. If it is sufficient to affect the yield materially, then the effect of phosphorus or nitrogen on the vegetative growth of a crop is almost

*By A. B. Stewart and E. M. Crowther, His Majesty's Stationery Office, London, Colonial No. 214, 1947, 28 pp., price sixpence.

certain to be considerable. In this case the results of treatments are estimated only visually, preferably by scoring on a scale from 1 to 10.

Many scientific workers in the tropics have hitherto been deterred from studying in detail and putting into effect modern factorial designs, because only unskilled labour and partly trained supervisory assistance was available. Actually for an experiment with a given number of plots, the labour involved and supervision required is much the same whether the design is simple or complex, and I have found that provided the application of fertilizer, planting, harvesting and stacking is done systematically, the nature of the design makes little difference. In my experience the greatest source of error lies in misreading the balance or scale, in "losing" plots owing to careless labelling, movement of the produce from a plot before weighing and, last but not least, in such arithmetical errors as forgetting to subtract the tare, or doing it twice. All of which is just as likely to occur with simple as with complex experiments, and can be avoided or prevented by proper organization of the labour, and by insisting that recordings only, and not even the simplest calculations, are made in the field.

It is hardly necessary to state that statistical methods of analysis can only be applied when the order of plots is randomized. In the simplest case, the order of three plots A, B, and C laid out at a number of centres, must be randomized afresh in each case, simply because if B always occurs between A and C, then A and C will tend to differ from each other more than they do from B, merely because they are farther apart. Further, in order to compare differences due to treatments with differences that are not under control, i.e. minor variations in soil and plant development, it is necessary to repeat or replicate similar treatments on different plots. By arranging the plots in blocks in such a way that every treatment (or balanced group of related treatments) occurs in each block, it is possible to measure the differences between blocks due to soil variations, etc. These differences are likely to be less within any one block, than between the different blocks in an experiment. This arrangement is known as the randomized block. Generally the blocks are made as compact as possible. In the Latin Square, differences due to soil, etc., are measured in two directions at right-angles, as the plots are so arranged that each treatment occurs once in every row and once in every column. Latin Squares of 16, 25, 36 and 49 plots have proved very efficient.

The effect of a particular treatment on the yield of a crop is usually modified to a greater or lesser degree by a large number of other factors. For example the response to mineral phosphate may be profoundly influenced by the addition of lime and/or nitrogen. In factorial experiments, all combinations of the different factors to be tested are made, and each combination is represented by a plot. If, as the result of such a trial, it is found that two varieties give the same yields over a wide range of manurial conditions, then it is reasonable to suppose that they would also yield the same over a wide range of soils. Similarly, if on plots with dung the response to phosphate are reduced to about one-half and those to potash are reduced to one-third of those on similar plots without dung, this is evidence that the benefit from dung must be in large measure due to the amount of available phosphate and potash it supplies. Indeed, factorial experiments testing combinations of dung or compost with individual fertilizers provide one of the few ways in which the manifold possible effects of such organic manures can be analysed into simpler terms.

All combinations of three factors at two levels (i.e. with and without) give eight different treatments; four factors would give sixteen different treatments, and so on. To include as many treatments as these in randomized blocks of early design would result in unwieldy experiments, and would at the same time provide a means of calculating complex interactions between three (or more) factors which would be most unlikely to have any real significance. By a device known as "confounding treatment interactions with blocks" it is now possible to identify certain of these complex effects with the differences between the blocks into which plots are grouped. This may be illustrated from the simple 8-treatment test on N, P, K fertilizers. The eight treatments—

Nil, N, P, NP, K, NK, PK, NPK

may be arranged in two sets of four, each of which forms a block, thus—

(*a*) Nil, NP, NK, PK

(*b*) N, P, K, NPK.

Each block still tests each fertilizer in the presence and in the absence of each of the other two, but the interaction of all three fertilizers become identified with the difference between the two blocks and is sacrificed in the interests of obtaining smaller blocks and greater control of local irregularities. Confounding has been widely and successfully used. All 32 combinations of the presence and absence of the elements N, P, K, Na and B in four blocks of eight plots have been used on sugar beet at some 20 centres in Britain over a period of years. Generally the effects from boron are small and seasonal, and evidence is accumulating that boron is not necessary on normal soils in most seasons. This evidence is obtained with no additional effort beyond applying the boron on half the number of plots, together with the other fertilizers. Here there is no absolute replication, as each of the 32 combinations of factors is represented by one plot only. In this case the error of the experiment is estimated from some of the high order interactions between combinations of treatments and blocks which can be regarded as being of no practical importance.

Certain cultural treatments cannot be applied to small plots, and in such cases it becomes impossible to design a fully factorial experiment. Thus cultivations, especially those major cultivations prior to planting, drilling dates, etc., may have to be given large plots, but these main plots may still be subdivided or "split" for two or more subsidiary treatments, i.e. fertilizers, into sub-plots. When plots are split in this way it must be remembered that the results from the main treatments on a few large plots are necessarily less accurate than those from the subsidiary treatments tested on a much larger total number of sub-plots. Splitting should never be used unless practical conditions dictate it, or unless the extra work in harvesting fractions of main plots is relatively small. It is often convenient to confound interactions for split plots. Thus half the splits in an experiment might be A and B and the other half Nil and A+B, thus confounding the interaction between A and B.

Useful information can be obtained from a series of local trials using the simplest of all possible experimental units. Patches of a crop in native gardens could be divided into differently treated halves to provide a series of two-plot blocks. Such comparisons need not be restricted to testing single factors. Two factors, e.g. N and P can be tested in this way by arranging the experiment in sets of six, to compare all possible pairs of the treatments Nil, N, P, N+P, thus:—

(1) Nil and N
(2) P and NP
(3) Nil and P
(4) N and NP
(5) N and P
(6) Nil and NP

The first four pairs give direct tests of each fertilizer alone and in the presence of the other, and the last pair gives the contrasts needed to balance the series and allow both the average effects of N and P and their interaction NP to be determined. Testing combinations of two fertilizers in this way is particularly useful on very poor soils in which both nutrients may be so deficient that adding one alone cannot produce a full effect.

The average response to fertilizers of the principal crops, and the average fertilizer requirements of the main soil types of an area should be measured by a series of annual experiments for which Dr. Crowther suggests the following factorial designs.

Using standard fertilizers at usually accepted rates of application, and including limestone, a sixteen-plot factorial experiment in two blocks of eight, confounding the highest order interaction, would be:—

(*a*) Nil, NP, NK, PK, NCa, PCa, KCa, NPKCa.

(*b*) N, P, K, Ca, NPK, NPCa, NKCa, PKCa.

If it is desired to include farm manure or compost as well, all five factors can be tested in 32 plots which may go in two blocks of 16.

To determine the optimal rate of manuring, the simplest way is to use a given fertilizer at rates 0, 1, and 2. A design with three factors each at three rates requires 27 plots, and these can be arranged with advantage in three blocks of nine plots. This design on N, P, K fertilizers has been used successfully in many countries during the last 15 years, and is recommended by Dr. Crowther as a means of studying the economics of manuring. A fourth factor may be introduced to make 81 plots, and the experiment may be laid down in sets of 27 plots in three blocks of nine plots each. In this connexion it should be

pointed out that a 3 x 3 x 3 x 3 design in 81 plots is much more convenient than a 2 x 3 x 3 x 3 in 54 or 108 plots.

In all comparisons of alternative fertilizer materials, the objective should be to find what rates of the two materials give similar effects on crops. Many wrong conclusions have been drawn from experiments made with too high dressings of manures, particularly with low-soluble phosphatic manures. Where the response to be expected is uncertain, a convenient design to compare two phosphate fertilizers is:—

OP, OP, 1P(A), 2P(A), 1P(B), 2P(B).

OP being nil-plots and 1P and 2P being two rates and P(A) and P(B) being two different kinds of phosphate fertilizer. To reduce the number of plots from the full 36 in a 6 x 6 Latin Square, Dr. Crowther recommends a 4 x 4 (or 5 x 5) Latin Square:—

		cwt. P_2O_5 per acre
1.	..	Nil.
2.	..	0.33 as standard.
3.	..	0.66 as standard.
4.	..	0.5 as first unknown.
(5.	..	0.5 as second unknown.)

The rate for the unknown will of course depend on its known or expected availability of P_2O_5. Where such an experiment has a second factor superimposed, e.g. nitrogen or no nitrogen, it is of course essential that all treatments should occur both with and without nitrogen.

A useful method of analysing the action of bulky organic manures, especially where two or more are of interest, is to use each at two rates and in conjunction with the presence and absence of fertilizers. A series of experiments has been successfully conducted in England recently with three bulky organic manures (each at two rates) and no organic manure, in all combinations in the presence and absence of sulphate of ammonia superphosphate and muriate of potash. This makes 4 x 2 x 2 x 2 x 2 or 64 treatments, but half replicate experiments with 32 plots in four blocks were used. Dr. Crowther gives an example of the confounding in his appendix and suggests that this type of experiment would be found useful in colonial agriculture to test the value of farmyard manure, and compost.

Where crop failure or unusual symptoms give grounds for suspecting minor element deficiencies, experiments can be laid out to test appropriate salt solutions applied to the foliage with a watering-can. The solutions should be given during a period of active growth early in the season, and may be usefully repeated. Again a factorial design of 32 plots could be used to test the effect of the presence and absence in all combinations of five minor elements, B, Mn, Cu, Zn, Fe. Where the unusual symptoms occur in patches and it is impossible to find a suitable site for the usual pattern of experiment, but where it is possible to find say eight patches, each could be divided at random into halves, and an experiment made on eight blocks of two plots. Confounding all first order interactions between four elements, a, b, c, d, the treatments to be given at random to the halves would be:—

Block	*Treatment I*	*Treatment II*
(1) ..	nil ..	abcd
(2) ..	a ..	bcd
(3) ..	b ..	acd
(4) ..	c ..	abd
(5) ..	d ..	abc
(6) ..	ab ..	cd
(7) ..	ac ..	bd
(8) ..	ad ..	bc

The usual method of applying fertilizers is broadcast in the seedbed, but there are many conditions where experiments will be required to investigate different times and methods of application. Nitrogen is often rapidly leached from the surface layers of the soil where it is normally taken up by the young roots. Phosphates are rapidly converted into very insoluble compounds quite unavailable to plants in certain soils. Under these conditions it has been found in both North America and Australia that a considerable economy in phosphatic fertilizers can be made by concentrating it near the seed and avoiding mixing it with the soil. Combined fertilizer seed drills have long been used for this purpose. Recently in the United States special machines have been developed for placing fertilizer in bands two inches on either side of row planted crops. This is particularly useful where the seed or the young roots are liable to damage by contact with fertilizer, e.g. many legumes. Dr Crowther therefore recommends that fertilizer placement be tested before adoption in a new area.

In light soils applications of nitrogen after sowing may prove more economic than at sowing time.

It is unsafe to judge fertilizer responses from the results of one or two years experiments only. Dr. Crowther quotes a case in point where for two consecutive seasons he had no response to fertilizer although clear responses had been obtained for the previous ten years. Many of the designs given are suitable for long-term experiments, and it would be sound policy to concentrate experiments on cumulative effects, residual values of fertilizers and on rotations at experiment stations.

The residual values of manures cannot really be studied independently from crop rotation. Obviously fertilizers must be applied at points in the rotation where they will be of greatest economic value. To eliminate seasonal differences all phases of the crop rotations must be present each year, but as each phase is actually a separate experiment, these do not need to be contiguous. A simple way of testing a residual effect is to have sets of plots receiving 0, 1, 2, units in odd years and 2, 1, 0 units in even years respectively, together with an appropriate number of plots permanently without fertilizer. Each season then gives immediate, cumulative and residual comparisons for a particular crop.

Experiments to compare alternative rotations are necessarily complicated, but there is an urgent need in Africa to analyse the effects of a naturally regenerated fallow against continuous cropping with various forms and durations of leys or periods under grass, to which I might add the effects of different intensities of grazing.

The value of field experiments can often be greatly increased by measuring and sampling the crop at various stages of growth and at harvest, and analyzing various parts of the plant for nitrogen or other nutrients likely to limit growth. The labour of harvest can often be greatly reduced by sampling a fraction of the total produce, e.g. with row crops to harvest and weigh the central 2 rows say out of plots 4 rows wide. This is actually more accurate than harvesting the whole experiment as by this means edge effects are eliminated. Similarly in threshing, provided samples are taken from all parts of any one plot, and are bulked and well mixed, the actual quantity weighed and threshed need only be a small portion of the total produce of each plot.

Dr. Crowther ends his paper with the very sound suggestion that to avoid unnecessary arithmetic all fertilizer analyses and rates should be given in terms of elements and not P_2O_5 and K_2O which are antiquated and now serve no useful purpose.

W.E.B.

CORRIGENDA

Vol. 12, No. 4, p. 240, to the Arusha names in the Veterinary Glossary—

for "Kidney, Engoshoke" *substitute* "Olairokuje".

for "Leg, Fore, Emure Muroshi" *substitute* "Ngejek Naituruk".

for "Leg, Hind Ngejek Naituruk" *substitute* "Muroishi".

for "Omentum" *insert* "Engurin" before Engoshoke, *deleting* "Engurinyo" (p. 241).

Vol. 14, No. 1, page 29, para. 3, line 6, *for* "absorption" *read* "adsorption". Similarly on page 29, para. 5, line 8; page 30, para. 6, line 9; page 31, para. 3, lines 9, 12 and 19; page 32, para. 1, line 7.

On page 29, para. 3, line 32, *for* "absorbed" *read* "adsorbed". Similarly on page 30, para. 4, lines 6 and 13; page 31, para. 3, line 17.

PROTECTION OF GRAIN AGAINST WEEVILS

By V. A. Beckley, Scientific Adviser, Pyrethrum Board of Kenya

(*Received for publication on 5th August,* 1948)

Introduction

The losses caused by insects to stored foodstuffs throughout the world are enormous. In 1946 the Food and Agricultural Organization of the United Nations estimated that at least ten per cent of the world's food supply was being destroyed by insects. In the U.S.A. it was estimated that in 1933 the losses caused by insect attack upon grain and grain products amounted to 300 million dollars. In the same year in Germany the grain weevil, *Calandra granaria,* damaged grain to the extent of 10 million R.M. These losses are due to direct attack on the grain and take no account of damage to good-will and other business losses.

If such losses can occur in temperate climates, where, during the winter, breeding ceases and some species of insects are killed by the cold, the losses in the tropics, where breeding is continuous, must, of necessity, be much greater. In Malaya for example, if rice is stored for more than eight months it becomes unfit for human consumption due to damage by insects. In Kenya, samples of wheat have been seen in which over 50 per cent of the grain has been severely damaged by weevil.

In East Africa, the main pest of grain is the rice weevil, *Calandra oryzae,* generally it is the first insect to attack the grain. As the infestation developes and frass (grain rubbish produced by insects) is produced, the rust-red flour beetle, *Tribolium castaneum,* is attracted. This insect generally lives upon the powder but it also attacks the grain. It further damages the grain by the production of a musty taint. Other insects of importance, especially in the cooler parts of the territories, are moths of the genus *Ephestia,* which lay their eggs on the grain. The young larvæ penetrate the germ which they devour during the first two stages of their development. They then leave the inside of the individual grain and wander about in the inter-granular interstices eating the germs. In all, during their life cycle, they destroy about fifty germs.

In a heavily infested stack of bagged grain the temperature rises, often considerably, and in Kenya a temperature of 130°F has been recorded. This is due to two main causes. The grain, being alive, produces heat which, in properly dried grain, is dissipated even though the heat conductivity of grain is low. The insects, especially in the larval forms, produce heat more rapidly than the grain. The temperature, therefore, increases and as it reaches about 80°–85°F., the rate of heat production by the insects increases. If there is a zone of intense infestation a hot zone is formed. At this point the adult weevils and other free living insects tend to migrate outwards and the hot zone spreads. Also, since heat cannot pass from the original hot zone to cooler zones, as it is surrounded by an increasing hot area, the temperature goes on rising until the death temperature of enclosed larvæ is reached. Indeed many adult beetles are often trapped.

With increasing temperature the hot grain loses water which, as vapour, moves by convection or diffusion into the cooler parts of the stack where it may be deposited in sufficient quantities to wet the grain and thus increase the rate of respiration, with a consequent rise in temperature. Incipient germination may occur, followed by attack by moulds. Both the heated and the wetted grain cakes into large masses, more or less spoilt by mouldiness.

The disinfestation of grain by fumigation is not so simple as it might appear. In silos direct fumigation is not possible owing to "sorption" of the best fumigants, hydrocyanic acid and ethylene oxide [1] by the grain. Penetration into the mass of grain is therefore poor. It is necessary to move the grain from one silo into another in order to secure proper fumigation. An interesting method is the addition of granular calcium cyanide to the stream of grain flowing into the silo. Fumigation of bagged grain can only be done in sealed chambers or under a gas-proof cover. It is a slow process only applicable to comparatively small stocks. It will be noted that carbon bisulphide is not mentioned as a fumigant. The very great fire hazard involved in its use on a large scale has rendered it obsolete.

Heat treatment of infested grain will destroy insects but the temperatures required also kill the germ and to a large extent some of the

enzymes. This is no disadvantage to maize intended for maize meal, but is a serious disadvantage with wheat, as the bread-making qualities of the flour are affected.

In the direct attack on the insects by means of insecticides one's choice of weapons is restricted to those which are non-toxic or relatively slightly toxic. In Britain, in order to protect grain and other foods against *Ephestia* spp. and to kill the caterpillars, when they crawl about on the surface, a pyrethrum spray, containing 1.6 per cent pyrethrins in a heavy refined paraffin oil (Shell P 31), is fairly widely used. It suffers from the disadvantage that it is purely a surface spray and cannot reach all the individual grains.

Finely powdered inert materials such as rock phosphate, magnesite, dolomite or diatomite have recently come into use. They are fairly efficacious against weevils and other beetles. Their action is strange. The beetles are dependent for most of their water supply upon the water produced in their own bodies by the combustion of their food. In order to prevent evaporation of water from the body surface, they have a waxy epicuticle which is impervious to water vapour. As the weevils move about in grain coated with the inert dusts, the waxy coating is scratched by the dust particles. From each of these scratches water is lost and eventually the beetles die through dehydration. Very fair protection is given by these dusts but there is still damage, more than can be afforded in these days of food shortage.

Both D.D.T. and Gammexane are lethal to weevils, but their use has not been permitted in grain intended for consumption, since their poisonous properties have not yet been fully worked out. Jepson in Tanganyika[2] has shown that the use of a gammexane-diatomite dust at a rate of one part per million of the gamma isomer of benzene hexachloride effectively protects grain against weevil attack. Melville[3] found that, at this rate, the rust-red flour weevil, *Tribolium castaneum*, was not killed. Recently the Ministry of Food has permitted the use of both these insecticides in foodstuffs; D.D.T. at the rate of 7 parts per million and B.H.C. at the rate of half a part per million of the gamma isomer. Whether these amounts will prove efficacious is yet to be seen, though Jepson has successfully protected grain with his dust at half rates for several months.

It is strange that although pyrethrum sprays have been used, pyrethrum powder and dusts have not been employed; probably because of the belief that the toxicity is ephemeral. Pyrethrum would appear to be ideal, since it is non-poisonous to man and other mammals and is intensely toxic to the insects infesting grain. Being an East African product, its use would not involve the expenditure of overseas credits. There is no objection raised to its use in quantities necessary to kill weevils.

Experimental

In September, 1947, an experiment was laid down to test the efficacy of pyrethrum powder and dusts against grain pests. Two grains were used, wheat and maize, in two qualities, clean and infested; unfortunately, the clean wheat became infested in transit and would be graded "slightly weevilly". Six treatments were employed, with four replications. The treatments were:—

(1) Control.

(2) Diatomite dust (Kensil) at the rate of 2 lb. per 200 lb. grain.

(3) 20/80 pyrethrum/Kensil at the same rate.

(4) 30/70 pyrethrum/Kensil at the same rate.

(5) 50/50 pyrethrum/Kensil at the same rate.

(6) 1 lb. commercial pyrethrum powder per 200 lb.

Since full size bags would have filled the insectary at my disposal, sandbags were used. In a way this was an advantage, as the open weave permitted free migration of the adult weevils. Each sandbag held 40 lb. of maize and clean wheat. Some of the infested wheat was so bad that, with difficulty, only 30 lb. could be put in. Mixing of the lots, however, gave fairly even samples, for each treatment.

The dusts were mixed with the grain by placing the four replicates for each treatment in a rotating drum and adding the dust in smalls lots, thereby mixing the materials evenly. The controls were also rotated since movement irritates the weevils and makes them migrate.

While weighing out the grain prior to incoporating the dusts, samples were drawn of several pounds weight upon which counts of live and dead *Calandra* and *Tribolium* were

made. The numbers, for the purpose of comparison, were reduced to a common denominator, 100 grams, which accounts for the apparent anomaly of a fraction of an insect. The counts per 100 grams for the materials at the beginning of the experiment were as in Table I.

TABLE I

Numbers of live and dead *Calandra* and *Tribolium* per 100 grams of grain

	Calandra		*Tribolium*		Moisture
	Live	Dead	Live	Dead	
					Per cent
Infested Maize..	28·2	22·3	0·6	1·1	9·6
"Clean" Maize	6·4	2·0	0·0	0·0	12·2
Infested Wheat	110·0	39·2	27·6	10·0	11·6
Clean Wheat ..	0·0	0·0	0·0	0·0	13·6

The moisture content of the grains was also determined by the xylene distillation method.

In order that the results could be examined statistically, and also to ensure proper distribution of foci of infestation, the bags were arranged in a properly randomized stack, the infested bags being thereby distributed evenly throughout the stack. At the outset there were twelve foci of infestation but a count at the end of a week showed that the unprotected bags of clean wheat were infested, thus providing sixteen foci of infestation in the stack.

At first the bags were placed on end in a block, with the bags touching, but it was noticed that the moving of the bags for sampling so irritated the weevils in the untreated bags that there was a heavy migration to the walls of the room. It was, therefore, feared that this migration might vitiate the results, so a normal stack, 12 bags long by 8 high, was made. This facilitated sampling, which consisted of drawing four or five probesful through the depth of the bag in slightly different directions. Disturbance of the bags by the process of sampling and subsidence due to the removal of samples necessitated the rebuilding of the stacks three times. These major disturbances have not affected the results as shown by statistical analysis.

For the first three months of the experiment, samples were drawn at fortnightly intervals. By this time it was apparent that the stack was in a state of equilibrium and little information of value would be obtained by the continuance of fortnightly sampling; two further samples were therefore made at much greater intervals. The counts involved a great deal of labour and I take the opportunity to tender my thanks to Miss Jean Sergeant and to the African staff of the Entomological Section of the Scott Agricultural Laboratories, who did this work.

The first count, a week after starting the experiment, revealed that there had been active migration and that the untreated clean wheat was infested; also that all the treatments had had an effect upon the weevil population. It appeared that in some cases the mechanical irritation of the diatomite dusts had caused both weevils and flour beetles to migrate. Migrants into the bags containing pyrethrum powder alone were quickly killed; for example, in the pyrethrum-treated bags of infected maize and wheat there were 53 and 103 more dead weevils than in the untreated, or, expressed in terms of bags of 200 lb. grain, approximately 48,000 and 93,000 more dead weevils per bag. Since a female weevil lays about 100 eggs in her life, and assuming an equal distribution of sexes, this means a reduction in potential infestation of 2½ and 5 million weevils per bag of infested maize and wheat respectively.

The effects became more marked with time. Even in the infested grain the numbers of weevils were substantially reduced as compared with untreated grain while in the lots treated with pyrethrum dusts and powders the numbers were nil, or almost so. The "infested wheat" was so spoiled that weevils were leaving it as unfit even for weevil consumption and breeding ceased. In the untreated "clean wheat" the numbers of weevils increased throughout the experiment.

In Table II are given the average weevil counts per 100 grams of grain for the four replications of each treatment for the first count a week after the experiment was laid down and that made in April, about seven months later. This summarizes the statements made above.

At intervals probesful were drawn of the clean wheat treated with pyrethrum. Not until the end of May, 1948, were live weevils found in appreciable numbers, about 2 per 100 grams, that is, the pyrethrum powder had given complete protection under conditions highly conducive to infestation for a period of eight and a half months. It was never suspected before that pyrethrum powder could have so long an effective life.

TABLE II

Average Live Weevil Counts per 100 grams grain early in and near end of Experiment

Grain	Treatment					
	None	Diatomite	20/80 Py/D	30/70 Py/D	50/50 Py/D	Pyrethrum alone
Weevily Maize—						
On 24–9–47	22·5	3·3	0·15	0·15	0·0	0·3
On 19–4–48	15·3	2·8	1·3	1·05	0·5	0·3
Clean Maize—						
On 24–9–47	32·8	15·5	6·9	3·05	2·6	3·6
On 19–4–48	9·6	5·9	8·7	14·6	2·9	0·0
Weevilly Wheat—						
On 24–9–47	65·5	14·1	5·5	2·8	0·75	1·7
On 19–4–48	12·7	5·2	0·8	3·7	0·55	6·8
Clean Wheat—						
On 24–9–47	7·8	0·5	0·0	0·0	0·0	0·0
On 19–4–48	73·4	34·4	2·8	0·2	0·0	0·0

Composite samples were drawn from the four replicates of each treatment. Fifty grams of each were weighed out, the damaged grain separated from the sound and each counted. The quantities were too small for reliable results to be obtainable with so large a grain as maize, samples ten times as large should be used, but other work prevented the replication of the counts. The most interesting figures are those for "clean wheat", Table III, which gives a picture of what happens to good wheat when exposed to weevil infestation.

TABLE III

Clean Wheat—Sampled 20–5–48

Lot	Treatment	No. of Grains in 50 gm.	Average Weight mg.	Damaged Grain
				Per cent
D1	Control	1480	33·8	59·3
		1430	35·0	55·2
		Av.1455	34·4	57·3
D2	2 lb. Diatomite	1231	40·6	13·4
		1231	40·6	11·6
		Av.1231	40·6	12·5
D3	2 lb. 30/70 Py. D.	1131	44·2	40·2
		1162	43·0	3·4
		Av.1147	43·6	—
D4	2 lb. 40/60 Py. D.	1144	43·8	0·0
		1151	43·5	0·3
		Av.1147	43·6	0·15
D5	2 lb. 50/50 Py. D.	1161	43·1	0·4
		1146	43·6	0·0
		1153	43·3	0·2
D6	1 lb. Pyrethrum Powder	1114	44·4	0·7
		1181	42·3	0·0
		1147	43·3	0·35

The most striking figures are those for the control and for treatments 4, 5 and 6. In the control, untreated, 57.3 per cent of the grains have suffered weevil damage, with the result that 308 more grains are needed to make up the weight of 50 gm. than in the pyrethrum-treated wheat; in other words, there has been a loss of more than 25 per cent of the food value of the grain. The diatomite has given fair protection as there are only 12½ per cent of the individual grains damaged, but this amount is still too great. Incidentally, the diatomite has had no effect on the germination of the sound grain, as demonstrated by a test made by the Seed Laboratories at the Scott Agricultural Laboratories. The figures in treatment 3 are most peculiar and cannot be correct, perhaps the African assistant who did the work was too stringent in his separation, since the average weight of a single grain is slightly higher than that of the duplicate. In all probability the figure of 3.4 per cent for damaged grain is about correct. The last three treatments have given complete protection for eight and a half months.

Discussion

While the figures above are of scientific interest, they do not show the effect of the individual treatments upon the monetary value of the grain. Accordingly, samples were drawn from all the treatments in the "clean maize" and "clean wheat" series and submitted to Messrs. Unga, Ltd., of East Africa, for valuation. Their reports, for which I tender my thanks, are given in Table IV. Weevil degradation in the wheat is done by separating the damaged grains in a weighed sample and weighing them. This accounts for the difference between the figures in Table III, calculated on numbers, and Table IV.

TABLE IV

Valuation of Grain from Experiment

Wheat

Sample No.	Bushel Weight lb.	Grade	Weevil degrade	Net Value
			Per cent	*Sh. cts.*
D1 ..	47	12	30·0	15 25
D2 ..	52	7	8·6	25 85
D3 ..	55¼	5	0·8	27 85
D4 ..	55¼	5	2·6	27 85
D5 ..	56	4	0·2	28 85
D6 ..	58	3	3·2	29 85

The net value is the amount a farmer would receive per 200-lb. bag and would be subject to variations in rail charge.

Maize

Sample No.	Bushel Weight lb.	Grade	Value
			Sh. cts.
B1 ..	52	7	29 35
B2 ..	53	6	30 35
B3 ..	51	8	28 35
B4 ..	52¼	7	29 35
B5 ..	54¼	5	31 35
B6 ..	57¼	4	32 35

Value is amount payable to the Agent per 200 lb.

The valuation of the wheat is most illuminating. It has often been said that the use of pyrethrum powder at the rate of 1 lb. per 200-lb. bag of grain is too expensive for the normal farmer. True, on the face of the value of a bag of clean maize of about Sh. 30 per 200-lb. bag, an application of pyrethrum costing Sh. 1/50, 5 per cent of the value of the wheat, may appear a great deal but, if the producer is forced to keep his wheat on the farm, very probably in a store infested with weevil, the value of his produce may fall to almost half, as has happened in the case of this wheat. Perhaps he may consider the protection afforded by "Kensil", being cheaper, is ample, but here too it will be noted that the value of the diatomite-protected wheat is four shillings less than that of the pyrethrum-protected. In fact his profit from the use of pyrethrum is rather more than Sh. 2/50 a bag over the diatomite-protected—still worth while. Incidentally, later experiments indicate that 8 oz. of powder would be ample per 200-lb. bag.

The valuation of the maize is difficult to explain. The material on the whole was well mixed, so it is hard to understand why B3, with a much lower weevil population than B1, should have a lower bushel weight; also why B6 should have so high a bushel weight. There also appears to be no weevil degradation as in wheat, perhaps because in maize the weevil destroys the germ rather than the endosperm which is the principal source of maize meal. Nevertheless, the difference in value between B1 and B6 is double the cost of the pyrethrum application. Had it been seed maize stored on the farm, the difference in value would have been much greater.

There is one point about the use of pyrethrum powder which has not been mentioned. The speed with which the weevils are killed is so great that before any oviposition can occur the insect is dead. Throughout the experiment neither larval nor pupal stages were found in any of the grain. These observations indicate that the use of pyrethrum in all the grain produced in East Africa, together with proper storage would, by the rapid destruction of adult weevils entering bags of grain, reduce the weevil from the status of a major pest to that of a very minor nuisance and at the same time appreciably increase the food supplies of these territories.

As regards hygiene, it cannot be denied that far too many grain stores are carpeted with a mass of loose grain, practically every one of which carries larvæ or pupæ of *Calandra* or *Tribolium*. If grain is stacked in such a store it will immediately be attacked and, as the attack starts from the bottom of the stack, hot zones are sure to develop and greater damage than that suffered in the experiment will ensue. Should there be no grain in store, the adult weevils will fly into neighbouring fields and infest grain in the ear. That this happens in Kenya is only too evident and frequent. Grain stores should be thoroughly cleaned of all loose grain and frass which should be burned. Even very thorough cleaning will not completely disinfest a warehouse.

There will be infested grain in cracks and crevices. Here pyrethrum will not do the job; one of the lasting new synthetics should be used in the form of a dust. The author prefers gammexane, which being rather volatile will penetrate into crevices. Probably, too, by the time the store is again used most will have been dissipated.

Although counts were not made of moth larvæ, *Ephestia spp.*, it can be definitely stated that these were never found in samples drawn from pyrethrum-treated bags, whether in the form of the diatomite-pyrethrum dusts or of powder, nor was there any webbing of the grain. Many larvæ were found in the samples from untreated bags. Farmers, in the higher areas where the rice weevil is a very minor trouble, can be assured that pyrethrum will adequately protect grain against the ravages of the larvæ of species of *Ephestia*.

SUMMARY

Damage to grain, mainly by weevils, *Calandra oryzae*, has reached such proportions as to raise it to the status of a major pest. The usual methods of fumigation to disinfest wheat are not generally applicable in East Africa; direct application of insecticides to grain appears to be the only solution of the problem.

D.D.T. and Gammexane cannot be used except in minor quantities. Pyrethrum is innocuous to man and stock, but it is generally believed to be ephemeral in its effects. In September, 1947, an experiment was started to compare the effects of inert dust, pyrethrum dust and pyrethrum powder. All the pyrethrum treatments gave excellent to complete protection for eight and a half months, a most unexpected life. The difference in value between the untreated and treated grain more than compensated for the cost of the treatments. It is suggested that if all grain produced be treated with pyrethrum powder, the weevil would be reduced to the status of a minor nuisance.

REFERENCES

[1] Much of the information in the general part of the introduction is derived from "Insect Pests of Food: The Control of Insects in Flour Mills", J. A. Freeman and E. E. Turtle, H.M.S.O., 1947.

[2] Jepson, W. J.—Private communication and Ann. Reports, Dept. of Agric., Tanganyika Territory.

[3] Melville, A. R.—Private communication.

"Tests in connexion with thrips on onions have been carried out in co-operation with the Division of Entomology to determine a practical method of combating this pest. It has been found that top-dressings of inorganic nitrogen fertilizers, causing vigorous growth of the young plants, made it possible for the plants to withstand thrips attack without the necessity for expensive spraying."—*Farming in South Africa*, 22: 264 (1947).

SUNFLOWER PRODUCTION IN THE IRINGA DISTRICT

By A. H. B. Childs, Agricultural Officer, Iringa

The sunflower (*Helianthus annuus*), which is a summer annual, can be successfully grown in all areas where maize is produced. It is distinctly drought resistant and will give good yields on soils too poor and in seasons too dry, wet or cold for good yields of maize. In Iringa District it crops on all types of soils from heavy clays to almost pure sands. Its altitudinal range varies from 7,000 ft. under forest conditions, to 3,000 ft. in arid thorn country.

The seed is an important source of oil which is used for edible oil, lard and butter substitutes, and in the preparation of paints and varnishes. It is also used in soap-making and in several other commercial undertakings. The seed contains about 25 to 35 per cent oil. The residue after the expression of the oil provides a valuable cattle cake. The head after the seed has been threshed is also a useful feed, If put through a cutter and mixed with succulents or maize, it will be readily eaten by stock and is akin to wheat bran in feeding value. In the dry season, cattle have been observed crunching the whole heads.

ANALYSIS OF HEAD AND SEEDS

	Crude Fat	Crude Protein	Carbo-hydrates	Crude Fibre
	Per cent	*Per cent*	*Per cent*	*Per cent*
Seeds ..	20–27	13–18	20	29
Kernels ..	45	27	16	3
Cake decorticated ..	9	38	22	16
Head meal ..	4–6	9	30–35	20–30

The plant in its green stage can be used for silage, but is not as suitable as maize for this purpose. It should be cut after it has come into bloom since, if cut too young, the silage will be sour and unpalatable. When mixed with maize the palatability of the product is greatly improved.

ANALYSIS OF SUNFLOWER SILAGE

	Crude Fat	Crude Protein	Carbo-hydrates	Fibre
Sunflower cut when 10 per cent in bloom ..	1·24	3·43	10·17	6·22
Sunflower cut when seeds fully formed	2·42	5·06	24·75	10·16

Sunflower is a cheap and easily grown green manure and will give a good bulk in areas where sunnhemp or velvet beans are not successful. The stems and heads contain a considerable quantity of potash and lime. An additional advantage is that it is a very effective weed-smothering crop and for this purpose it should be broadcast at the rate of 45–55 lb. per acre.

It should be remembered that the crop is very susceptible to attack by eel-worms and therefore should not be grown in rotation with tobacco other than as a "Trap Crop". The crop is easily ploughed under with an ordinary three-furrow disc-plough.

An alternative is to broadcast mixed sunflower and sunnhemp or sunflower and cowpea. The seeding rates for these mixtures are:—

30–35 lb. sunflower and 20–25 lb. cowpea or 30–35 lb. sunflower and 20–25 lb. sunnhemp.

Cultivation follows the same lines as for maize but need not be so exacting. One ploughing and disc-harrowing is sufficient. Once the plants are 1½ ft. high very little further cultivation is needed. If planted on ridges or on the flat it is advisable at the first cultivation to ridge the soil around the plants as they are liable to lodge when fully mature. A method used in Iringa District is to plant on the flat with a maize planter, and ridge with a ridge plough when the plants are 6 in. to 8 in. high. Cultivation between ridges should cease when the plants reach 1½ ft. high since injured plants do not recover easily. Manuring the crop is not generally practised, but it should follow a crop which has been manured or fertilized. The yield of seed is reduced on lands heavily manured or on very rich soil since "blind" heads are produced.

The crop should be planted after maize (Iringa mid-January) which will allow for the harvesting to take place after most of the rain has fallen. The distance between the rows is generally 3 ft., if a maize planter is used. When they are 6 in. to 8 in. high the plants should be thinned out to between 15 in. to 18 in. It has been observed that single plants produce a better crop than two to three plants in a clump.

Eight to ten lb. of seed is sufficient to plant an acre and the depth of sowing should

not exceed 2 in. to 2½ in. For silage or green manure the distance between the plants should be 8 in. to 10 in., the seed being broadcast and covered by a light disc-harrowing or tooth-harrowing.

The crop requires four and a half to five and a half months to mature according to the area in which it is planted. High altitude plantings taking longer to mature than low.

The heads should be cut before they are quite ripe. Considerable waste will occur by shedding if the heads are allowed to mature in the field. Harvesting should take place when the rains have ceased. A useful method to adopt is to cut the heads and lay them upwards between the rows for a few days to dry. They should then be collected in bags and taken to the place where they are to be threshed. The crop is very uneven in ripening and it will be necessary to go through the field several times in order to harvest at the correct stage of maturity.

There are several methods of threshing, e.g. beating with sticks, rubbing by hand over a piece of expanded metal on a wooden frame or putting the head through a maize sheller.

The seed when threshed should be spread out in a thin layer and turned; it should not be bagged until quite dry. For export it is advisable to winnow the crop to remove empty husks and rubbish.

The average yield for the district is in the neighbourhood of one-third to half a ton per acre, this is on unmanured land. Even on the poorest of soils a reasonable crop can be harvested. The highest recorded yield was three-quarters of a ton per acre.

Great care should be taken in selecting seed and only good seed should be planted. The following points should be borne in mind when selecting:—

(*a*) Only heads which are above the average size and with well-filled kernels should be chosen.

(*b*) Plants which are multiple-headed should be discarded as these are more difficult to harvest and give a smaller yield.

(*c*) Plants which shed their seed easily should also be avoided.

(*d*) Plants which produce an abundance of leaf-growth are desirable.

(*e*) The angle of the head on the stalk should also be noted. Plants which produce flowers which do not bend completely over are easily eaten by birds as the flower forms a platform for them to stand on.

(*f*) Plants which are short should be selected as they are easier to harvest.

The crop is fairly free from disease in Iringa District. The worst pests are birds which do considerable damage, especially to plants with upright flowers. Cutworms have caused damage to young plants in their early stages. Kromnek disease has been reported from the Mbeya District but has not as yet been recorded in the Iringa District, although the disease is present in tobacco. Sclerotinia disease has been reported from the Njombe District, but has not as yet been observed in Iringa. The disease is not seed-borne and it is therefore hoped that Iringa will remain free.

Sunflower provides the long needed cash crop for the African farmers on the "miombo" soils of the Iringa District. The crop was first tried on a very small scale in 1947 when seed was distributed free to Africans in all areas of the district. The crop flourished from 7,000 ft. in the forest belt to 3,000 ft. in arid thorn country. This season it has been planted on a large scale by European, Asian and African farmers.

At the present price the crop is an attractive one, especially on the "miombo" soils, which produce very small yields of both maize and wheat. Approximate net costings excluding land rent and capital overheads are given below, these costings apply to non-native farmers using tractor-draught; the African could produce the crop very much cheaper.

	Sunflower Sh.
Ploughing (per acre)	20 00
Cross-ploughing	—
Disc-harrowing	15 00
Drilling	5 00
Harvesting and threshing	10 00
Bags at Sh. 2/50	10–25 00
Transport at Sh. 2 per bag	20 00
Total cost of production per acre	95 00
Cash return (at half a ton per acre)	Sh. 260 00
Total cash return (per acre)	Sh. 260 00
Difference between cash return and cost of production	260 00 95 00
	Sh. 165 00

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AN INTERNATIONAL MEETING ON INFESTATION OF FOODSTUFFS

Interest in losses caused by insects to food grains during storage decreased in the early years of the present century as railways and steamship routes linked up new areas of cheap production with consumers all over the world. The ease with which local shortages of food could be met by importations from the other side of the globe—providing of course that somebody could make a profit out of the transaction—and the organization of trade so that stocks did not require to be held for long periods, all served to hide the fact that storage pests were everywhere ready to seize any opportunity to increase the amount of damage they could do to crops after harvest. The First World War with its interruption of communications brought these facts to light, so that producers had to hold large stocks of grain they could not ship, and consumers were so short that "normal losses" due to storage insects could no longer be afforded. The lesson was not well learnt, because soon after the war larger crops were produced, the result of unplanned exploitation of new farming areas, and maize was used even as locomotive fuel in South America. In the thirties the situation began to look less satisfactory as "dust bowls" became news, and a rapidly increasing world population, coupled with the spread of industrialism to more and more countries who had been exporters of foodstuffs, these factors conspired to narrow the gap between supply and demand. World War Two with its dislocation of food production and distribution, coupled with the unrelenting spread of soil erosion, the continued increase in population and the increasing demand for higher standards of feeding, this has further served to bring the problem of food supplies to the fore. It is now generally agreed that we can no longer afford to share our crops with storage pests, even at the conservative estimate that they destroy ten per cent of the harvest each year.

Thinking in terms of East Africa alone we have examples of all the factors contributing to food shortages—an increasing population, the drift from the land to towns, a succession of bad harvests during the war when extra food could be obtained from other continents only with great difficulty and at great expense, and soil erosion—brought on in some cases, at least, by the same over-production of food grains that caused the "dust bowls". A problem which we share with the rest of the world is the preservation of foodstuffs to prevent needless waste in all years, and to enable the surplus of the good year to be held in reserve for the lean year.

In August, 1947, the Food and Agriculture Organization of the United Nations held an International Meeting on Infestation of Foodstuffs in London. Papers read at this meeting have now been published* and experts from Great Britain, Canada, Australia, France, Belgium, China, Egypt and the United States present a world picture of the problem. The main purpose of the meeting was to bring to bear on the problems of infestation control the knowledge of entomological experts throughout the world and the accumulated experience of technologists who are responsible for translating the results of scientific information into practice. F.A.O. has accepted the function of inspiring increased development of the world's food resources so as to remove the possibility of "want". An essential part of the plan is that surpluses shall be husbanded carefully to provide against shortages. This brings into high relief the question of maximum storage life according to location, commodity and storage construction.

The British Ministry of Food has a two-fold responsibility to the people of the United Kingdom. Not only has it a general duty to see that the people are fed and that waste is avoided at every stage, but also it must support the ration by controlling the supply of staple commodities.

The controlled supply may be accommodated in public warehouses in which private supplies of susceptible and, possibly, infested commodities may be stored, and it is necessary for the protection of controlled and private food supplies alike that infestation of the commodities and of the structures themselves should be closely controlled. The Ministry has found that voluntary response is the more readily forthcoming if the willing trader knows that the unwilling can be brought into conformity. Success lies largely in securing the goodwill and co-operation of the trading community, backed by legal powers of

* F.A.O. Agricultural Studies, No. 2. Preservation of Grains in Storage; Washington, U.S.A., 1948.

requirement to be exercised sparingly and reserved to the appropriate level of responsibility.

A survey of world foci of infestation and the principal channels of dissemination of storage pests demonstrate that the main concentrations of population which consume the maximum quantities of goods lie in the temperate parts of the world, particularly in North-western Europe and North America. The principal movement of susceptible materials is from areas of agricultural production to those of industrial manufacture. As far as the U.K. is concerned, the areas from which the most heavily infested commodities are received are South Africa, tropical Africa, India, Burma and Malaya and the Pacific Islands. During the years 1944–46 East Africa supplied 38 species of storage pests per annum out of a total number of 190 (West Africa heading the list with 90), those most frequently found being the Rust-Red Flour beetle, *Tribolium castaneum*, the dried fruit moth. *Ephestia cautella*, and the rice moth, *Corcyra cephalonica*. Naturally, the nature of the produce shipped will govern to a large extent the storage pests it will carry. Oilseeds, whatever their origin, tend always to be heavily infested. Cereals and cereal products depend on their country of origin for the degree of infestation normally encountered. Dried fruit and nuts, except those from the U.S.A., generally arrive with appreciable infestations.

The infestation of raw materials for the preparation of beverages and spices (cocoa, coffee, tea, nutmegs, etc.) is generally moderate to heavy. Although insects cannot breed on tea, the rate of superficial infestation of tea is high, due to cross-infestation according to country of origin.

When goods are carried in ships, as is the main bulk of susceptible produce at some stage on its movement from producer to consumer, cross-infestation from one part of the cargo to another and residual infestation from previous cargoes varies with the route. It is frequently high on the India and West Africa to U.K. routes. On a ship from South and East Africa, for example, numbers of beetles and moth caterpillars had found their way into the corrugations of corrugated cardboard cartons enclosing canned jam, which had been originally breeding in cottonseed, the main bulk of the cargo. Carriage by land is not without its dangers. Clean goods may become infested, during discharge, by contact with infested goods, or when placed in lorries or railway wagons which had previously carried infested goods. An example is given where newly milled flour loaded at a flour mill at Norwich on to an open platform lorry, which had been carefully swept before loading, was found on arrival at Slough, 60 miles away, to be infested by larvæ of *Trogorderma granarium*. Investigation showed that these insects had emerged from under the platform floor, although the lorry had not carried any goods from which they could have come for at least six weeks previously.

In the tropics, conditions are generally favourable for the rapid continuous breeding of storage pests. Localized heating of dried grain, or produce such as groundnuts which is infested with insects to generate heat in itself, will enable pests to maintain themselves even in a northern winter and, one might add, the higher elevations in East Africa.

Among the several hundreds of different insects which damage foodstuffs in storage, the greatest loss is caused by those which are capable of breaking through the tough seed-coat of the whole grain.

The rice weevil, *Calandra oryzæ*, is the most destructive of these, and next in importance is the grain moth, *Sitotroga cerealella*. Most of the other insects come into the picture when these two have broken into the grain, or after the grain has been processed. One serious pest of stored grain not yet known to be present in East Africa is the Khapra beetle from India, *Trogoderma granarium*.

Much work has been done in the United States on the problem of farm grain storage. Prevention is regarded as much better than cure. Where curative measures become necessary, it it obvious that preventative measures have been inadequate. It is considered essential to provide storage bins that are clean and free from insects, and that will protect the grain from the weather and moisture. Steel bins caulked at the seams with a plastic material applied with a caulking gun are preferred, since they can be made weather-tight, are easily cleaned, and can be successfully fumigated.

In Australia the damage done by insects and rodents to wheat stocks held up by the shortage of shipping during the first world war was not forgotten during 1938 and 1939 when another war seemed inevitable. An extensive research programme was sponsored by the Commonwealth Council for Scientific and Industrial Research. Successful emergency storage of

wheat of low moisture content was achieved in bulk by ensuring:—

(1) That both the roof and floor of the shed was sound and waterproof.

(2) That the grain mass had a minimum surface area. This means in practice that the mound should be built to the greatest height that the angle of repose will permit.

(3) The surface was easily accessible.

Mineral dusts proved of great value as protective barriers over the exposed surface. Carbon bisulphide was used for surface fumigation where insect infestation developed in bulk or in stacks of bagged grain.

In the oasis and villages adjacent to the Egyptian Desert, grain is sometimes stored in sand ditches. In the absence of termites and infiltering water, grain keeps well and remains free from infestation if initially very dry. In other areas of Egypt the chief method is the *shounas*. This is simply a small piece of cleared land surrounded by walls or fences and subject to rainfall, the ravages of birds, rodents and the usual grain pests. Crops thus stored are a source of infestation to crops grown in the surrounding fields. Silos constructed of brick and each capable of holding 15 tons of grain are now being built in groups throughout the Delta.

Finally, we have the conclusions of Charles E. Palm of Cornell University, who discusses the needs for international co-operation in research and its application to problems of insect control: "Insects do not respect political boundaries in their distribution, nor have they respect for race, creed, or colour. They are living organisms in direct competition with man for many of the commodities essential to life. They are endowed with a magnificent capacity for reproduction and increasing in numbers. Through commerce many species have become cosmopolitan as exemplified by the major stored-products pests. Even more will be distributed over the face of the earth in this era of air transportation. It is essential, therefore, that we recognize the magnitude of our task, the need for whole-hearted co-operation among professional workers of all nations, and support of their work by the governments concerned if we are to go forward successfully in the struggle for insect control. Education is a keynote in the fight. The people concerned with the losses must understand their nature and methods by which they can be prevented. Passive resistance and recording of losses must give way to an aggressive program directed towards prevention and control. The exchange of workers and the training of qualified students on a world-wide basis is essential in the long range program. We cannot hope to accomplish our objectives shortly—it is a continuing program which must be understood and supported by the people everywhere, adapted to local methods and conditions, but with the common objective of preventing the destruction of those common foods and fibres for which both men and insects struggle."

W. V. H.

A SYSTEM OF COMPOSTING FARM AND VILLAGE WASTE

By F. B. Wilson, M.B.E., Agricultural Officer, Kenya

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The value of well made compost is recognized amongst farmers, vegetable growers, or gardeners who have practised composting and observed the results upon their crops and soils. It is true that a few, in their enthusiasm, may be constrained to make somewhat extravagant claims for the merits of compost, but the majority of compost users appreciate that they have, in this substance, a readily available plant food and soil fertilizer which it would be difficult to equal. Under tropical conditions, in particular, the organic portion of the soil is liable to become rapidly depleted under cultivation resulting not only in the direct loss of plant foods by oxidation and leaching but also in the deterioration of those physical qualities which are so difficult to describe and assess, e.g. crumb structure and the capacity of the soil to absorb and retain moisture.

The regular practice of composting soils which are subject to continuous cultivation and cropping, as in market gardens, not only maintains but also builds up the plant nutrient status and improves their physical condition. In this connexion a recent article by F. C. Cooke [1] is of the greatest interest in showing how the leached infertile soils of the P.O.W. Camp at Changi were, by successive light dressings of properly made compost, induced to yield increasingly large crops of green vegetables.

If the value of compost has been so conclusively proved and is so widely recognized, why is it that compost making is not more generally practised? One reason is the complicated nature of many of the processes advocated. Simple as it may appear on paper that heap A must be turned on to position B on the fourteenth day after making, and on to position C after another specified period, it is often difficult for the busy farmer to remember when each of the comparatively numerous processes must be carried out. Thus, in time, the composting station becomes a series of rubbish dumps which are just left to rot down, or the process is abandoned altogether. What is required then is a system which is simple, not too expensive in labour, and which, within reasonable limits, will run itself with the minimum of supervision.

It is believed that the system described in this note complies with the above-mentioned requirements. It has also stood the test of actual working, under varying conditions, in the islands of Zanzibar and Pemba for over five years. At the Kizimbani Experimental Station every bit of farm waste and household refuse from labour village and staff quarters is composted in the manner described. The results from the use of this compost on citrus nurseries, banana blocks, and many other field crops are most marked. Near the town of Zanzibar over 600 tons of compost per annum are prepared from refuse from the town dairies and other waste materials. In the east coast village of Chwaka the whole of the village refuse has been successfully composted under the supervision, until lately, of the local African dispenser. Other units in the districts of Zanzibar and Pemba have been going for several years.

General Principles

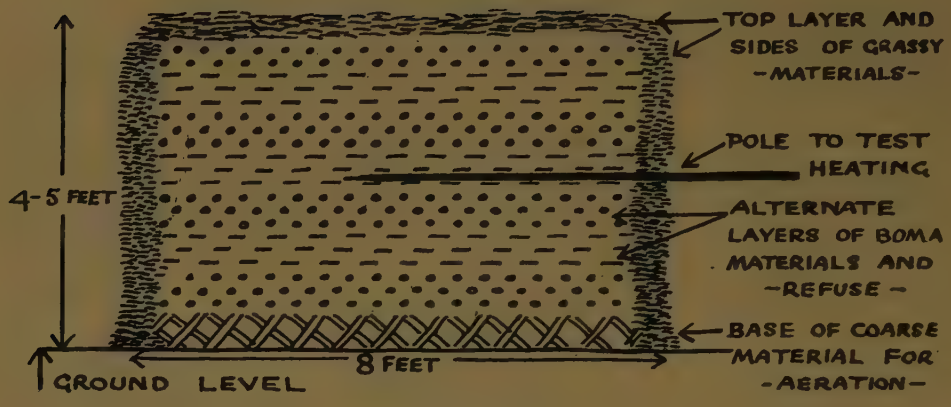
An essential requirement for successful compost making is a fairly regular supply of vegetable waste in bulk. Without this it is impossible to make full use of trained labour. Also of great value is cattle manure or, better still, the use of cattle to tread down and soak with urine much of the materials used; systematic operation of the method is also essential, there is all the difference in the world between proper compost heaps and a series of rubbish dumps. In order to avoid the latter and to make sure that the work, properly started, is *regularly maintained* it has been my practice to site the compost factory right at the centre of operations, that is to say beside the farm headquarters, or alongside a main road, or where it is plainly visible. In this way tidiness and regular supervision is obligatory to those in charge and one can be sure that the daily deliveries of materials and household refuse are not just dumped anywhere to become fly breeding heaps of rubbish. I have witnessed this happen in several instances where the compost factory was sited in some "convenient" spot behind trees or buildings. Make the composting centre, then, a "show piece" on farm or village site and the system will work.

COMPOST MAKING AT THE KIZIMBANI EXPERIMENT STATION, ZANZIBAR

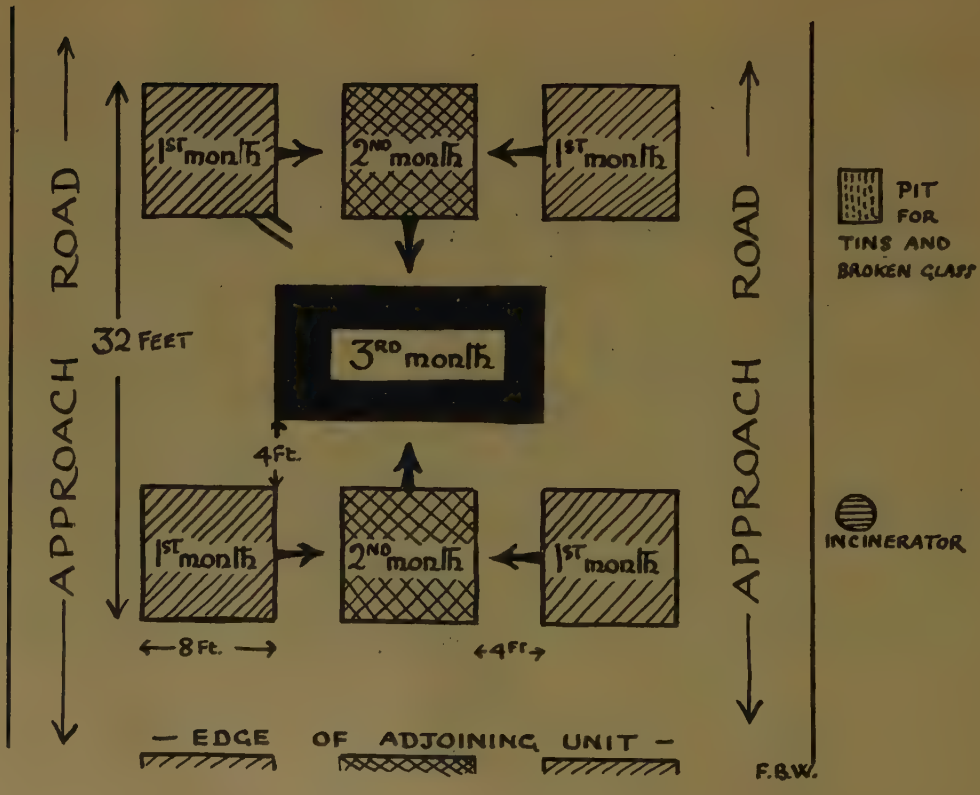
A battery of three composting units in line with approach tracks each side. (One unit is outlined in white.) The small shed on the left protects the incinerator from rain. The cattle shed is within thirty yards on the right.

A SINGLE BULLOCK REFUSE COLLECTING CART. This type of cart with high sides and removable tail board can collect a huge quantity of household refuse quickly and economically.

COMPOST HEAP IN CROSS-SECTION



GROUND PLAN SKETCH OF ONE — COMPOST UNIT —



Adequate moisture is essential to the composting process. If a heap is too dry it merely becomes a haystack, remains quite cool, and the material takes months to rot down. It is also possible for material to be too wet; for example, when too great a concentration of wet coffee berry pulp is used, but this condition is less common than lack of moisture. The correct degree of moisture is largely a matter of experience, sometimes it is necessary to add water at the time of making up the original heaps or when turning. Cheaper and more satisfactory, if possible, is to use urine-soaked litter from the cattle pen and such "wet" material as chopped up banana stems, canna leaves, or other vegetable material containing a high proportion of moisture. It may be observed, in passing, that once a heap is made rain, however heavy, fails to penetrate very far and therefore the heap should be uniformly moist when made. Under Zanzibar conditions and with the materials used, the amount of water added was not large.

It is usually recommended that some of the mature compost be mixed in with the new heaps as a "starter". Where material from the cattle pen is available for mixing in with the vegetable waste no additional "starter" is necessary. Indeed, with a well made heap under this system it is amazing how rapidly the internal temperature rises, indicating full scale bacterial activity.

Collection and Treatment of Rubbish

In the collection of household waste from labour lines, dwelling-houses, or village settlements, it is necessary to provide some receptacles or collecting bins. Old petrol tins are excellent for this purpose for individual houses, whilst for labour lines some larger receptacles such as halved 40-gallon drums are admirable. These drums are cut horizontally and, where possible, two half drums are provided for each group of houses: into one are put all the "soft" easily rotted materials, whilst into the other goes the hard and woody waste stuff such as coco-nut husks and shells, cassava stalks, etc. The best method of insuring that these drums are not stolen is to punch holes in the bottom so that they cannot be used for water.

For crop residues such as maize stalks, rice straw, bean and pea haulms and pods, sweet potato tops and the like, there is no better treatment than to throw these into a covered cattle pen where they are picked over by the cattle, thoroughly broken up and well impregnated with dung and urine. Under present conditions a very great deal of urine is completely wasted whereas, by this system, not only is this valuable plant nutrient saved but also it is utilized to provide the moisture essential to the composting process. When the compost heaps are made up daily some of this material from the cattle shed is used for mixing, in layers, with the other ingredients of the heap. All woody and hard materials which will not rot down easily are collected from the refuse as it arrives and are burned in a simply-constructed incinerator, the ashes then being incorporated in the compost heaps. Where rain is frequent, as in Zanzibar, a small shed roofed with old corrugated iron or flattened out petrol tins is invaluable for the collection and burning of woody refuse. An efficient incinerator can easily be made from an old oil drum with a piece of expanded metal two-thirds of the way down supported by a couple or iron bars. A rough-hinged door at the bottom enables the draught to be controlled and facilitates the removal of ashes. Without such a shelter as described waste materials such as cassava stalks, coco-nut husks, pineapple stems, and the like are apt to be left lying about, get sodden with rain, and prove very difficult to dispose of.

Method of Making Compost

Under the system described one "unit" consists altogether of seven heaps laid out within a square. Four initial heaps are at the corners of the square; these, after one month, are made into two heaps; after a further month they become a single heap in the centre. The layout of the unit is shown in the accompanying diagram and also by the photograph. A freshly made up heap is approximately 8 feet square and up to 5 feet high. It is convenient to mark permanently the corners of the heaps by stout wooden pegs standing two feet high. The corners of the unit are marked by 5-ft. poles.

In making up a heap the first thing, as in rick making, is to make a good foundation of rough material such as maize or sorghum stalks to a depth of about one foot. This allows of a certain amount of aeration which is essential to the composting process. Thereafter alternate layers, six to twelve inches thick, of household refuse alternating with material from the cattle pen are built up. All available wood ashes are added to the layers as they are built. The heap is always finished

off with a layer of dry grass or other suitable material at least six to twelve inches thick. This serves the double purpose of making the heap unattractive to crows or chickens (which will scatter household refuse far and wide if given an opportunity) and of preventing fly breeding on the cooler periphery of the heap. As an additional safeguard against fly breeding the outside edges of the heap are composed almost exclusively of grassy material, the household rubbish being kept well inside the heap. As the inside portion rapidly reaches a temperature of 160° F., or more, all fly eggs or larvæ are killed. A properly constructed heap has almost vertical sides and a flat top. About half way down one side a long sharp stake is inserted, with its point well into the centre of the heap. This can be withdrawn from time to time to test the internal temperature of the heap, and to make sure that the processes of decomposition are proceeding satisfactorily. In this connexion, I cannot do better than to quote Cooke [1]:—

"The temperatures attained within the heaps were a measure of the micro-biological activity. Wooden testing rods were used to prove the heaps. If they emerged cold and wet, either the reaction had not started or there was too much moisture; if only slightly warm, dry, and showing traces of white mould, the heap needed more moisture, and if conditions were just right the stick emerged hot, moist, and stained dark-brown. Conversely, if the stick was free from slime and rank smell, and could be pushed back easily, the compost was ready to use, but if there was any resistance, the material was not ready.

The addition of urinated water was a matter of judgment and experience. It was usually added each day after the final layer of waste had been liberally sprinkled with ash, the amount depending on the quantity of succulent material present, care being taken not to add too much and not to wet the lalang walls. The heaps were usually watered again on turning if visible white mycelial strands of fungi indicated an insufficiency of moisture."

Provided the heap has been properly constructed and has adequate air and moisture, bacterial activity increases at an amazing rate and after two or three days the temperature inside the heap is such that the testing stake is almost too hot to touch. Towards the end of the month the heap cools down and is then ready for the first turning. Each two corner heaps of a unit are amalgamated into a single heap as shown in the diagram. This process is both simple and effective, since the material is completely turned and well mixed up with the minimum of labour. It may be necessary during the turning to sprinkle some water on every foot layer as it is made up.

Having performed the first turning and mixing, four new corner heaps may now be made up. Meantime the second month heaps warm up and ultimately cool down again in much the same manner as the freshly made heaps. It will be found that after approximately one month these intermediate heaps will be ready for their second and final turn. The two second month heaps are thus amalgamated to form one central heap. Again some watering may be necessary when turning, though this was not usually the case under Zanzibar conditions.

It will be seen both from the above description and the diagram that this system starts with four heaps and ends up with one. In the process of decomposition the volume of the material decreases considerably so that in size the final heap of mature compost is not much greater than a single initial corner heap.

At the end of the third month the material should have decomposed to a dark coloured humic material ready for storage or immediate use. If necessary, it can be put through a coarse-mesh sieve and the residue of incompletely decomposed material put back into a fresh heap. It cannot be too strongly stressed that compost must be fully mature before use otherwise it may actually, in some cases, reduce crop yields. Strictly speaking mature compost should be stored under a roof but, as handling and transport are expensive, it will be found quite adequate to protect the central heap with a layer of dry grass or straw.

Some Uses of Compost

Under Zanzibar conditions compost has been applied, with conspicuous success, to vegetable plots on poor sandy soils, to various plant nurseries, to fields of bananas and paw-paw, and in tree-planting holes in many parts of Zanzibar and Pemba. It has also produced obviously beneficial effects upon permanent grass.

It must, however, also be noted that experimental application of compost to certain field crops such as maize and rice, have produced some very unexpected and, as yet unexplained results.

Some considerable difficulty has been experienced in the Chwaka (east coast of Zanzibar) experiment in getting villagers even to take away the compost free. This is partly due to ignorance of its properties, and mainly due to difficulties of transport. If a man has to walk a quarter of a mile with a tin weighing 30 lb. on his head, it is not likely that he will use very much compost. If, however, hand carts, wheel-barrows, and single bullock or donkey carts were more readily available on loan, I do not think it would be long before compost supplies were keenly taken up by cultivators. With regard to town compost it is gratifying to record that whereas in 1943 and 1944 over half the production was given away free, the major portion of compost produced is now sold to meet a steady demand.

Summary

There is no doubt that at present a great deal of home, village, and town refuse goes to waste in East Africa. Much cattle urine is also lost. This note describes a simple system of composting whereby all waste materials can be converted into one of the most valuable crop fertilizers. The system described is applicable where fairly large quantities of waste are available. It is not suitable for the small man in his back garden, but if he has a covered cattle pen he could not do better than throw all his waste trash beneath the feet of his cattle.

With the increase of population in East Africa and the decrease in soil fertility, the problem of conserving every possible source of plant and animal food is a matter of urgent concern. The composting of town, village, and farm refuse is but one aspect of the general problem of conservation; it is one, however, to which greater attention is warranted. It is hoped that this note will induce others to explore the possibilities of composting under various conditions and to resurrect the practice where, owing to unsuitable methods, it has declined.

Acknowledgment

There is nothing either very novel or revolutionary in the method of composting here described. It was developed under the direction of Mr. J. C. Muir, O.B.E., from 1942 onwards, when he was Director of Agriculture of Zanzibar. The whole practice of composting in Zanzibar and Pemba was greatly encouraged and developed by the then British Resident, Sir Guy Pilling, K.C.M.G., to whose enthusiasm much of the success of the town and village composting programme, now in operation, is due.

References

[1] F. C. Cooke.—"Intensive Gardening in a P.O.W. Camp". *Malayan Agricultural Journal*, Vol. XXX, No. 1.

[2] Annual Reports of the Kizimbani Experiment Station, Zanzibar, Department of Agriculture, Zanzibar, 1944, 1945, 1946.

"Breeding work with tomatoes at the Nelspruit Research Station has produced new strains which are absolutely immune to the bacteria wilt disease which causes havoc in the Eastern Transvaal. Back-crossing and inbreeding is still progressing with a view to combining this immunity with a better quality commercial variety of tomato."—*Farming in South Africa*, 22: 264 (1947).

THE AMANI PLANTATIONS

An Account of some of the more interesting Horticultural Features to be seen at the East African Agricultural Research Institute, Amani, Tanganyika Territory

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Amani is situated on the eastern slopes of the Eastern Usambara Mountains in Tanganyika Territory, latitude 5.06° south, longitude 38.38° east. It is about fifty miles distant by road from the port of Tanga. The whole area of the Institute occupies some 750 acres, of which approximately 500 acres are devoted to the plantations, the remainder being under tropical rain forest. The altitudinal range is from 1,300 feet to 3,700 feet approximately, and in consequence most of the plantations are sited on excessively steep slopes. The laboratories, staff residences, and village are built on the crests of a series of ridges at an altitude of approximately 3,000 feet, while the nursery occupies the flat land in a river valley.

The average rainfall is approximately 77 inches per annum, and is moderately well distributed compared with the rest of East Africa. The humidity is extremely high; the annual mean temperature is 68.9° F., with a mean daily maximum of 76.3°F. and minimum of 61.5°F.

The Institute was first established in 1902 by the Government of German East Africa. During the 1914–1918 war the resources of the Institute were used by the Germans for the local manufacture of medical and other supplies, and the available buildings were occupied as a refugee camp for German women. British forces took over Amani in 1916. After the war, the Institute was absorbed into the Department of Agriculture until 1927, when the East African Agricultural Research Station came into being as a separate organization.

The heavy work of clearing the original forest and the planting of the majority of the permanent tree plantations was carried out by the Germans prior to the 1914–1918 war. Starting at the lowest extremity of the plantations (altitude 1,300 feet approximately), the following is an account of some of the most interesting horticultural features to be seen from the main paths and roads.

In the north-east extremity, bounded by a small river there is a large plantation of the cigar-box cedar, *Cedrela odorata* L., and a lesser one of the toon tree, *Cedrela toona* Roxb. Proceeding in a south-westerly direction, the next plantation is one of the para rubber, *Hevea brasiliensis* Mull. Arg. Planted in 1912, these are mostly in good condition and were intensively tapped during the recent war. Two other smaller plantations of para rubber are to be found in this area. Good quality sheet rubber was produced, the whole process up to baling being carried out at the Institute. Ceara rubber was also produced from trees of *Manihot glaziovii* Mull. Arg., most of which had naturally regenerated, were of unequal size, often inaccessible, and generally difficult to tap. Yields were low and production could not have been considered to have been an economic proposition in normal times.

Below the path there can be seen a more recent planting of kapok, *Ceiba pentandra* Gaertn., several trees of Arabian tea or khat, *Catha edulis* Forssk., and the bay-rum, *Pimenta acris* Kostel. Beyond the para rubber there is a large plantation of another light timber, *Toona serrata* (Royle) M. Roem. Next come a few rows of the cola or kola nut, *Cola nitida* A. Chev., the reddish-purple seeds of which are used as a masticatory in West Africa, and also as a beverage, being a component of the American drink Coca-Cola. On the other side there are some trees of the coco-nut palm, *Cocus nucifera* L., the unopened inflorescences of which are tapped daily for the toddy which is used locally as a yeast for bread-making.

Continuing along the path one comes to a row of the sandbox tree, *Hura crepitans* L., a large tree with a spiny stem. The round flattened fruit is divided into sections, which dehisce explosively; they may be used as paper-weights if the hollow centres are filled with lead. The tree is liable to become a menace if allowed to spread unchecked as is evidenced in an adjacent plot of the oil palm, *Elaeis guineensis* Jacq., where it has adopted a strangling habit on a number of trees.

The path now winds up through a plantation of one of the African mahoganies, *Khaya anthotheca* C. DC., at the base of a comparatively recent landslide. At the top of this

path, where it meets the old motor road, now blocked by the slide, is a group of *Pithecolobium dulce* Benth. This makes a good neat hedge in the warmer parts of East Africa particularly at the coast.

Next to some bread-fruit trees, *Artocarpus communis* Forst., is an attractive plantation of the betel nut palm, *Areca catechu* L. Looking down on these from the road, one sees rows of tall slender stems, crowned with a small cluster of graceful palm leaves, below which the orange-yellow fruits are borne during the dry weather at the beginning of the year. These fruits, or rather the nuts contained therein, are much relished by the local Indian population, who use them, together with the leaf of the betel vine, as a masticatory. A few specimens of the Brasilian wax palm, *Copernicia cerifera* Mart., are to be found in a corner of this plot. Carnauba wax, used in the manufacture of polishes, etc., is obtained from the undersides of the leaves of this palm.

After passing more plantations of *Cedrela* spp., we come to a plot of *Lagerstroemia speciosa* Pers. (syn. *L. flos-reginae* Retz.). Although rather overshadowed, the pink flowers of these trees are certainly a striking sight when in full bloom, deserving the Indian name Queen of Flowers or Pride of India.

Beyond these are a number of clumps of bamboos among which can be noticed an attractive black-stemmed bamboo, the male bamboo, *Dendrocalamus strictus* Nees., and the giant building bamboo, *Gigantochloa aspera* Kurz. ex Teijm. and Binn. Above the road and a little further on is a plot of teak, *Tectona grandis* L.f., followed by a collection of miscellaneous fruits, while below again is another plot of coco-nuts. Adjacent to this is an interplanted plot of trees, growing on which is the black pepper, *Piper nigrum* L. It is not always generally realized that the "black" and "white" peppers are the product of the same plant. The latter is obtained by removing the outer covering from the peppercorns, which are the dried berries of the "black" pepper. The ripe berries are much sought after by birds, who have been responsible for spreading the plant into other plantations in the vicinity.

In this area are to be found plantings of the manilla hemp, *Musa textilis* Nee., which is a species of banana. Growth is not good, however, and the district is not suitable for the cultivation of this crop.

Coming out on to the main road, one is faced with a few trees of the black silk dye *Diospyros mollis* Griff. non Wall. Next to these is a collection of *Agave* spp. brought together for breeding work on sisal. Flanking the road are two specimens of the horse or pink cassia, *C. grandis* L.f. Behind is a collection of *Citrus* spp. and varieties and other miscellaneous fruit trees, including bread-fruit, jak-fruit, *Artocarpus integra* Merr., mango, *Mangifera indica* L., and avocado pear, *Persea americana* Mill. By the side of the road can be noticed a single specimen of *Posoqueria latifolia* Roem. and Schult., its clusters of long tubular white flowers being very handsome when fully opened. A small shrub with scarlet flowers immediately strikes the eye as one moves on, and can be identified as *Quassia amara* L., the Surinam Quassia or bitter wood. Apart from being one of the sources of the drug Quassia, it is also a very handsome ornamental shrub. Opposite this is a good specimen of the tallow or butter tree, *Pentadesma butyracea* Sabine., of which the symmetry, coupled with the creamy wax-like flower buds, make it a striking and unusual tree. The fleshy seeds contain an edible oil.

On the other side of the road there is a small group of the henna dye, *Lawsonia inermis* L., while above is a short avenue of the rubber *Castilla elastica* Cerv. Above this again are more fruit trees, including the bilimbi, *Averrhoa bilimbi* L., and the carambola, *Averrhoa carambola* L., the latter bearing a most curious fruit, ovoid and angular in shape, and of a rich amber colour. It is very juicy with a rather acid taste and is sometimes used for making jelly.

Continuing up the road one passes more citrus and other fruits, including the mamey, *Mammea americana* L., and some *Annona* spp., until one comes to a species of *Hydnocarpus, H. ilicifolia* King., one of the sources of chaulmoogra oil used in the treatment of leprosy. This has a curious velvety-black fruit. Behind these are a few trees of the nutmeg, *Myristica fragrans* Houtt., the fruits of which are eagerly sought after by the native population. Even the erection of a formidable stockade fails to preserve the crop when ripe. The nutmeg is an important spice, providing both the nutmeg, which is the kernel contained in the fruit, and mace, which is the aril surrounding the nut. This latter is a bright scarlet colour when fresh. The tree is dioecious, male and female flowers being borne on separate plants. Attempts to propagate by cuttings have not been successful, but

elsewhere it is reported to have been propagated by layers and by inarching.

At the crest of a small steep rise, there is a small plot of the mangosteen, *Garcinia mangostana* L. This is generally considered to be the most delicious of all tropical fruits. The white juicy pulp adhering to the seeds is the edible portion; this is arranged in segments and encased in a thick reddish-purple rind or skin, which contains tannic acid and a dye. The fruits when ripe are about the size of a tennis ball. By exerting pressure with the thumbs at the point of attachment of the stalk, the ripe fruits are easily split and the edible segments extracted. The great draw-back to the fruit is the presence of the seeds, and if the plant-breeders could produce a seedless variety, it would indeed be a fruit *par excellence*. Propagation is usually effected by seed, but seedlings are inclined to be slow and weak in the early stages; other vegetative methods are desirable if they could be perfected. There is a definite tendency towards biennial bearing at Amani.

Adjacent to the mangosteens on the lower side of the road are some trees of the physic nut, *Jatropha curcas* L., which are supporting vines of a beautiful vanilla orchid, *V. imperialis* Kranzl. The flowers are a gorgeous reddish-purple and cream, borne in large clusters intermittently throughout the year. Behind the mangosteens on the other side is a specimen of *Warszewiczia coccinea* Klotzsch. This is a small tree, bearing showy vermilion inflorescences in large sprays, and is not unlike a large poinsettia in general appearance. Nearby is a small tree which flowered for the first time in 1945. Introduced as *Amherstia nobilis* Wall. in 1934, it has turned out to be *Saraca indica* L., the leaves of which are somewhat similar. Although beautiful, it cannot be compared with the famous *Amherstia*, and has proved a big disappointment. There is no *Amherstia* at Amani, nor anywhere in East Africa so far as I am aware. In the same plot are a few small specimens of the Japanese persimmon, *Diospyros kaki* L.f., not growing well and obviously out of their element, requiring a somewhat cooler climate.

Proceeding up the road, we now come to a small palmetum, ideally situated between the road and the river. A magnificent specimen of the cabbage palm, *Roystonea oleracea* (Jacq.) Cook (syn. *Oreodoxa oleracea* Mart.), is to be seen here, also a smaller and younger plant of its close relative the Royal palm, *Roystonea regia* (H.B. & K.) Cook (syn. *Oreodoxa regia* H.B. & K.). Amongst other palms can be seen *Bactris utilis* Benth. and Hook.f., the peach-nut with its wicked-looking spines on the stems; *Aiphanes caryotaefolia* (H.B. & K.) Wendl. (syn. *Martinezia caryotaefolia* H.B. & K.); *Howea* sp.; *Arenga saccharifera* Labill.; *Ptychococcus paradoxus* Becc.; *Areca triandra* Roxb. and its variety *bancana*; *Arecastrum romanzoffianum* (Chamisso) Becc. (syn. *Cocos plumosa* Hook.f.) the feathery coco-nut palm; *Wallichia caryotoides* Roxb.; *Attalea macrocarpa* Lindl.; *Raphia* sp.; *Acanthorrhiza warscewiczii* H. Wendl.; *Caryota mitis* Lour., the fish-tail palm; *Livistona chinensis* R.Br.; *Livistona cochinchinensis* Bl.; and *Licuala peltata* Roxb.

Next we come to a small plantation of cocoa, *Theobroma cacao* L., interplanted with light shade trees amongst which are some handsome specimens of *Peltophorum dasyrachis* Kurz. Growing on an island in the river is a single small specimen tree of the Brazil nut, *Bertholletia excelsa* H. et B., probably the only one in existence in East Africa. It has not yet flowered. Just above, the river is very beautiful with the feathery bamboo, *Bambusa vulgaris* Schrad., the sago palm, *Cycas revoluta* Thunb., cannas, and the raphia palm, *Raphia monbuttorum* Drude, growing by the water's edge. Raffia fibre or bass, so widely used by gardeners for tying purposes, is easily prepared from the leaves of this palm. Here also is a single specimen of the palm *Nephrosperma vanhoutteanum* Balf.f. Above the road is a plantation of the oil palm, *Elaeis guineensis* Jacq., the seeds of which are a big attraction to a large troop of baboons which roves the neighbourhood.

The road now crosses the river by a small bridge and commences a long steep ascent, zigzagging up 1,500 feet for a distance of nearly five miles. There are nine hairpin-bends and one S-bend in this stretch. Most of the plantations on the hill are tree crops, amongst which can be noticed the oil palm, teak, kapok, *Mundulea sericea* (Willd.) A. Cheval., *Cassia siamea* Lam., and *Calophyllum inophyllum* L. Lining the road are some clumps of the feathery bamboo, the Indian almond, *Terminalia catappa* L., and more *Cedrela* spp. Just above the S-bend there are some small plots of fruits, including Guava, *Psidium guajava* L. and *P. cattleianum* Sabine, loquat, *Eriobotrya japonica* Lindl., and litchi, *Litchi chinensis* Sonn. The latter bears attractive fruits, crimson in colour when ripe and about

the size of a plum. Unfortunately it is much favoured by birds and ripe fruits are consequently a rarity at Amani. A collection of eucalypts, the gum trees of Australia, is now visible together with other tree crops, including a small plot of *Derris dalbergioides* Baker., a pretty tree when in flower with its purplish-pink blossom. Further on we come to a plantation of the Chinese wood oil tree, *Aleurites montana* E. H. Wilson. These are young trees, selections from the Tung Research Station in Nyasaland, and are only just coming into bearing. Tung oil, a drying oil, much valued for the manufacture of paints, etc., is obtained from the seeds of this tree. There are other older and larger trees of this plant at Amani, and the crop is grown commercially in the neighbourhood. The trees are a striking sight when in flower, being somewhat reminiscent of cherry trees. There are also a few trees of the true tung oil, *A. fordii* Hemsl., but their growth is very stunted and the climate is definitely too warm for them.

Rounding the last corner, one comes to the outskirts of Amani proper, with the first staff residence on the ridge on one's left. A fine example of the toddy palm, *Caryota urens* L., is to be seen here with its flowering spadices, many feet long, hanging down in huge bunches, like gigantic horse tails.

In the valley are two trees of a good local timber mvule, *Chlorophora excelsa* Benth and Hook.f. Climbing up these, and completely draping even the smallest branches of one of them, is the magnificent creeper cat's claw, *Doxantha unguis-cati* Rehd. (syn. *Bignonia unguis-cati* L.). Adhering by means of clawed tendrils, its bright yellow flowers are borne in great profusion, usually in December. Unfortunately the flowers are short-lived and drop after four or five days. Nearby is a small plantation of two species of *Erythroxylum*, from which the drug cocaine is obtained. The commercial cultivation of this crop is forbidden throughout the British Empire, and also in a number of other countries, but the plantation at Amani was extended at the beginning of the war in case there should be difficulty in obtaining supplies. A native of South America, it is a shrub, bearing attractive small red berries, and is normally raised from seed, which should be sown fresh, though it will root from cuttings. The drug is obtained from the mature leaves which are plucked and shade-dried, usually attached to the twigs.

Above this plantation are a number of *Cupressus* and *Juniperus* spp., growing at the bottom of an open pasture. Further along are some trees of *Schizolobium excelsum* Vog., a handsome leguminous tree with long feathery bipinnate leaves and bright yellow flowers borne in large erect sprays at the commencement of the warmer weather in October, when the trees are devoid of leaves. Also in this area can be seen some good specimens of *Araucaria* spp., including *A. bidwillii* Hook. the bunya-bunya pine; *A. brasiliana* Richards; *A. cookii* R.Br.; and *A. cunninghamii* Ait. the Moreton Bay pine. Beyond these are two magnificent specimens of the Nandi flame tree, *Spathodea nilotica* Seem. Indigenous to Uganda and Kenya, their large bright orange-red flowers render them a striking and conspicuous object at a distance. Behind these is a well-grown specimen of the beautiful shrub *Medinilla magnifica* Lindl. It's rose-pink flowers are borne in large pendulous sprays against a background of large deeply-veined leaves. *Encephalartos hildebrandtii* Br. and Bouche, a slow-growing cycad, can be seen close by.

Proceeding on up the road, one comes to another house, near which is a very fine specimen of the Norfolk Island pine, *Araucaria excelsa* R.Br. Approximately 90 feet high, it is probably about 45 years' old, and is this year fruiting for the first time. Its perfect symmetry makes it a handsome and striking object, especially at a distance. Growing nearby are three mature specimens of *Petrea kohautiana* Presl., often confused with *P. volubilis* Jacq., known as purple wreath. It is one of the most beautiful of all flowering plants, with large racemes of violet-coloured flowers, borne two or three times a year. The corolla is like a small velvet violet set in a lighter violet papery calyx, which persists long after the corolla has fallen. It may be propagated by stem and root cuttings, or layers.

On the crest of this ridge are two well-grown and nicely shaped jacaranda trees, *Jacaranda ovalifolia* R.Br., framing another staff residence. The jacaranda is a very beautiful tree, bearing a profusion of bluish-purple flowers at the beginning of the warmer weather, the East African Spring, usually about October at Amani. Even when not in flower, the bipinnate mimosa-like foliage makes the tree very graceful and ornamental. Growing beneath one of these jacarandas is another *Petrea;* this often flowers at the same time as the jacaranda, and, viewed from afar, the colours appear almost identical. There is

a magnificent view from this point; on a clear day it is possible to see the sea, and even the waves breaking on the reef, through a gap in the hills to the east, some thirty-five to forty miles away.

In the valley to the east of this ridge and fringing the main road, is a plantation of Ledger's cinchona, *Cinchona calisaya* Wedd., var. *ledgeriana* Howard. It is from the bark of this and other species that the drug quinine is obtained, Ledger's bark being especially rich in quinine. Cinchona grows well at Amani, and is grown commercially in the neighbourhood. The bark is harvested and dried. Propagation is usually by seed, though cuttings and grafts are successful. The flowers are quite attractive with a pleasant scent.

Beyond this plantation, in the same valley, is a plot of tea, *Camellia sinensis* (L) Kuntze (syn. *Thea sinensis* L.), which also grows well. Now that restrictions have been lifted, the planting of this crop is also being developed in the district, though lack of suitable seed supplies is rather limiting the acreage at the present time.

To the west of the ridge mentioned above lies a somewhat broader valley in which the nursery is situated. This has been the nursery since the plantations were first started by the Germans, and it has, therefore, become somewhat exhausted, and a large part of it is now resting under elephant grass. However, an interesting collection of ornamental shrubs is maintained and propagated for distribution, mainly in Tanganyika, where there is now no professional nurseryman. The young stock is mostly raised from cuttings in the propagating frames, some of them with glass lights, and all with artificial shade of bamboo strips or hessian, raised well above the frames. When rooted, the young plants are potted up into pots made out of sections of bamboo, in which they remain until sold. These afford a useful method of growing and transporting the young plants.

By the nursery office, growing on a grassy bank, is a collection of bougainvilleas, all trained as standards. This is a most effective way of growing these popular climbing plants where space is limited, though the ideal is probably to allow them to run riot over some large tree, where such is available. Amongst the varieties to be seen here are the ever-popular purple-crimson Mrs. Butt; Lady Wilson, very similar; Maharaja of Mysore, an Indian pink; two pale-pink varieties, Lady Hudson and another unnamed one, neither being very floriferous; a gorgeous dark brick-red variety from Dar es Salaam; and the orange Mrs. Maclean, a sport from Mrs. Butt, to which it is rather prone to revert, as well as other varieties.

Near to the bougainvilleas are two trees of *Tabebuia pentaphylla* Hemsl., the pink flowers of which are borne when the tree is bare of leaves, and are an exceedingly beautiful sight. Below these is a single specimen of *Aglaia odorata* Lour., a small tree, the flowers of which are sometimes used in perfumery, and are a great source of attraction to bees. Opposite this is a climbing plant *Camoensia maxima* Welw., which has the distinction of bearing one of the largest leguminous flowers. It is white and orange-yellow in colour and sweetly scented, and is ramping over a small indigenous tree. Here also can be seen some slow-growing cycads, including *Encephalartos horridus* (Jacq.) Lehm., *Dioon edule* Lindl., and *Zamia pygmara* Sims. emend. Schuster (syn. *Z. pumila* Hort.).

Next comes a collection of sugar and fodder canes, some 80 varieties being represented. Adjacent to these are the rose propagation beds, and the greenhouses of the East African Quarantine Station. Beyond is the major part of the shrub collection, amongst which can be noticed the following: *Acalypha hispida* Burm.f.; *Ardisia oliveri* Mast.; *Asystasia bella* Benth. and Hook.; azaleas; brunfelsias; a single variety of *Camellia japonica* L.; cestrums; eranthemums; *Euphorbia fulgens* Karw.; *Galphimia brasiliensis* A. Juss.; a selection of varieties of *Gardenia*; *Gmelina hystrix* Kurz.; two species of *Holmskioldia;* a number of ixoras; *Jacobinia carnea* Nichols; *Jasminum sambac* Soland; lantanas in various colours; the common privet, *Ligustrum vulgare* L.; *Lippia citriodora* H.B. & K., lemon verbena; *Malvaviscus arboreus* Cav.; *Montanoa bipinnatifida* C. Koch, the daisy tree; two flowering bananas, *Musa uranoscopos* Lour. (syn. *M. coccinea* Andr.) and *M. rosacea* Jacq.; myrtle, *Myrtus communis* L.; varieties of *Pentas* in various colours; three species of *Philadelphus; Phyllanthus nivosus* Bull, var. *roseo-pictus* Hort.; the red and blue plumbagos; *Russelia equisetiformis* Schlecht and Cham.; *Scutellaria costaricana* Wendl.; *Spiraea cantoniensis* Lour., the cape may; *Streptosolen jamesonii* Miers.; *Strobilanthes dyerianus* Mast.; *Tibouchina semidecandra* Cogn.; and *Wigandia urens* Choisy.

Passing on we come to the propagation beds and frames, while nearby is an old German plant house, which is partly used as a propagating house, and also houses a few orchids, including Cattleyas, Vandas, Dendrobiums, Epidendrums, Renantheras, and Coelogynes. Behind this are some vines of the commercial vanilla, *V. planifolia* Andr. The flowers of this must be hand-pollinated in order to obtain the pods from which the flavouring is produced.

Crossing the river, we come to a collection of climbing plants, trained on wires. These include the pink and the white coral creeper, *Antigonon leptopus* Hook and Arn.; numerous species of *Bignonia* and *Clerodendron; Dipladenia brearleyana* Hort.; various species of *Ipomoea, Jasminum,* and *Lonicera*; *Manettia bicolor* Paxt.; *Odontadenia grandiflora* Schum.; *Oxera pulchella* Labill.; *Quisqualis indica* L.; species of *Solanum*; *Stigmaphyllon ciliatum* Juss.; and *Thunbergia grandiflora* Roxb., both blue and white varieties.

Nearer the river is a very fine specimen of a bottle-brush tree, *Callistemon speciosus* DC. In the same border is a small shrub, *Ardisia crispa* A. DC., the red berries of which are very attractive. Finally in this area can be seen a single bush of *Feijoa sellowiana* Berg., which bears attractive flowers of a silvery-mauve with crimson stamens against a background of felty grey leaves. The fruits are edible.

Turning back, we now proceed on up the hill to a cross-roads where eight roads meet. In passing can be noticed a bush of *Eugenia uniflora* L., the Pitanga cherry, the fruits of which are a bright cherry-red when ripe. At the cross-roads itself is a single tree of the allspice, *Pimenta officinalis* Berg., which flowers profusely but unfortunately fails to set seed at Amani. Behind this is a bush of the Bay-laurel, *Laurus nobilis* L., while beyond can be seen a plantation of cinnamon, *Cinnamomum zeylanicum* Bryn. The young leaves of the latter are very beautiful, varying from a bright pink to a deep crimson. The spice is obtained from the bark. Nearby is a small specimen of *Magnolia grandiflora* L. This tree is now thirteen years old; it flowered for the first time two years ago. Below this is a small plot of *Melaleuca leucadendron* L., the cajeput oil tree. The flowers are like white bottle-brushes and the bark is of a curious soft paper-like texture which can be torn off in large sheets. The latter can be used for torches. An essential oil is obtained from the leaves.

At the bottom of the valley below these is another specimen of *Schizolobium excelsum* Vog. This is an enormous tree, much bigger than the others previously mentioned, and is a magnificent sight when in flower. Proceeding on up the main road, there are two trees of *Liquidambar styraciflua* L., the sweet gum. Before falling, their leaves turn an attractive crimson, providing autumnal tints during the cool season. Next to these are two trees of *Michelia champaca* L., the flowers of which are heavily scented and provide an essential oil, used in the manufacture of cheap perfumes. The scent is almost overpowering when the trees are in flower, round about Christmas time. Beyond these is a small plot of the Paraguayan tea or Yerba de Mate, *Ilex paraguariensis* A. St. Hil. It is a native of South America, where an infusion from the dried leaves is prepared and drunk as tea.

Passing various tree crops, we now come to a small specimen of *Baphia kirkii* Baker, which bears attractive papilionaceous cream-coloured flowers. Beyond this is a row of an unusual *Grevillea, G. hilliana* F. Muell., bearing white flowers at the tips of the branches. Adjoining these are plantations of miscellaneous eucalyptus planted for fuel and timber supplies. Finally in this section, before reaching the Amani village, is a plot of *Eucalyptus ficifolia* F. Muell., the crimson flowered gum. The flowers of these are very striking, ranging from white through shades of pink to a deep red, the latter shade being the most common.

Above the road here is a clump of a small *Melaleuca, M. hypericifolia* Sm., which has red bottle-brush flowers. There are a number of *Cassia* spp. in this area, including *C. bacillaris* L.f., the cockrico bush, with attractive pale yellow flowers; *C. multijuga* Rich., with deep golden yellow flowers; and a single specimen tree of the lovely pink *C. nodosa* Buch.-Ham., also known as jointwood. Here also can be seen species of *Pandanus*, the screw-pine, and *Plumeria*, the frangipani, a large succulent shrub bearing large corymbs of highly fragrant white, cream, or red flowers.

At the top of this hill is the administrative centre of Amani, where the main offices, post office, and laboratories are situated. Behind the main office building is a specimen of a most unusual tree, the cannon-ball tree, *Couroupita guianensis* Aubl. Its curious fleshy pink and white flowers are borne on woody

racemes arising from the main trunk along its entire length. Individually they give the appearance of a small fancy cake. The large brown globular fruits, from which the tree takes its popular name, take many months to ripen, and are only starting to be borne at Amani after some 45 years. It is unlikely to succeed in the drier parts of the country. Another single specimen tree which is not often seen in East Africa is *Lysidice rhodostegia* Hance, a handsome leguminous tree which can be seen nearby. It bears loose panicles of rose-purple flowers with pale pink scale-like bracts which persist long after the flowers have dropped, and is a striking sight when in full flower.

In the garden of the Director's house, adjoining the office buildings, can be seen a large shrub of *Murraya exotica* L., the orange jasmine, which bears white-scented flowers not unlike the citrus to which it is closely related. An essential oil is extracted from the flowers and is used in perfumery. A specimen of *Cycas circinalis* L. emend. Schuster sub. sp. *madagascariensis* (Miq.) Schuster can also be seen here.

In a valley on the other side of the main office buildings are plantations of tea, para rubber, india rubber *Ficus elastica* Roxb., *Grevillea robusta* A. Cunn., the silky oak of Australia, and *Maesopsis eminii* Engl. The fruits of the last-named are a great attraction to hornbills, who have been responsible for spreading the tree in open spaces in the surrounding forest. The remainder of this area was originally devoted to tropical fruits, but the majority have died out through *Armillaria* root disease. Among those remaining are a single tree of the litchi, and two species of *Flacourtis,—F. cataphracta* Roxb. and *F. rukam* Zoll and Mor. Near the top buildings are some more specimens of the *Araucaria* spp. previously mentioned, and also one of the Cashmere cypress, *Cupressus cashmeriana* Royle, the latter being especially handsome with its very glaucous foliage.

Turning from here past the workshops and down towards the river, one passes a giant climbing *Bauhinea, B. vahlii* Wight and Arn., which has completely covered a large tree of *Canarium schweinfurthii* Engl. Beyond this are some tree bauhineas, both purple and white, the latter being particularly floriferous. Above these are a few shrubs of the attractive *Grevillea banksii* R.Br., rather like a larger edition of *G. rosmarinifolia*, which is probably better known to most gardeners in temperate climates. At the bottom of the hill where the road joins the riverside road are three trees of the tree heath, *Erica arborea* L. This is found in the higher parts of East Africa and it is surprising to find it thriving and flowering well at this comparatively low altitude. Here also is a specimen of the trumpet tree of Tropical America, *Cecropia peltata* L. Its large palmate leaves, which are reputedly utilized as sandpaper, render it distinctly ornamental. The hollow shoots are used for making musical instruments.

Across the road is an old German plant house, where a number of herbaceous plants and orchids are growing. Amongst others can be noticed species of *Anthurium, Saintpaulia, Isoloma, Episcia, Billbergia, Begonia, Cattleya, Dendrobium, Epidendrum, Coelogyne, Gongora,* as well as a number of ferns, selaginellas, and some local orchids of little horticultural importance. A single plant of *Hoya carnosa* R.Br., the wax-flower is growing up one of the supports. This has not yet flowered in this position, though rooted cuttings from it, grown in pots, have been flowered successfully. Creeping over the whole house, which is shaded but unglazed, is the small creeping fig, *Ficus pumila* L. Outside are a few shrubs, including *Aphelandra tetragona* Nees., with scarlet flowers borne in erect heads, and a number of varieties of *Hydrangea opuloides* Koch., which flower but are very dwarfed and not really suited to so warm a climate. A small collection of succulents is growing on a rocky and sandy mound by the entrance to the plant house, but these also do not relish the climate which is naturally too damp for them. Nearer the river a specimen of the giant honeysuckle, *Lonicera hildebrandtiana* Collett and Hemsl., can be seen ramping over a small indigenous tree, while planted along the road in this corner are some small plants of the royal palm. Proceeding on past the plant house we come to another small palmetum by the side of the river in a clearing in the forest. Very conspicuous here is a specimen of the travellers tree, *Ravenala madagascariensis* Gmel. Its immense leaves assume the form of a gigantic fan, and are arranged similarly to those of the bird of paradise flower, *Strelitzia reginae* Banks, which also grows at Amani, and to which it is very closely related. The large sheathing leaf-stalks form receptacles in which considerable quantities of water are stored. If the

lower end of one of these is pierced, a jet of water will spurt out; hence the popular name.

Rounding the corner one is surprised to come upon a lovely little lake in a beautiful setting, with natural forest on two sides. The other sides are grassed near the water's edge, with cannas in a variety of colours grouped at one end, their reflection in the water being an added attraction. On the near banks, a collection of flowering shrubs has been planted among the grass. White arum lilies, *Zantedeschia aethiopica* Spreng., grow by the water's edge, while in a small stream that feeds the lake can be found water-cress. Red, blue, and cream-coloured water lilies grow in profusion, a local small-flowered blue one becoming a weed if left undisturbed. Similarly, the giant arrow head, *Sagittaria montivedensis* Cham. and Schlecht, spreads most prolifically; introduced into the district by the Germans in the early days, it has now become naturalized. A word of warning must be given about parrot's feather, *Myriophyllum proserpinacoides* Gill., an aquatic plant with feathery leaves. Introduced just before the war, it soon spread and choked half the lake at a time when labour was scarce, and no time could be spent in eradicating it. Even now, weekly excursions are necessary to keep it in check, and its complete elimination is unlikely; it must be classed as a potentially dangerous water-weed. The lake is stocked with a local species of fish (*Tilapia*), which unfortunately never attain any appreciable size here. A punt is maintained, and the visitor can usually see one or more brilliant blue kingfishers flying about.

Up a side road from this area, there is a remote plantation consisting of plots of grafted coffee, mostly *Coffea canephora* Pierre (syn. *C. robusta* Linden), some *Cinchona josephiana* Wedd., and a collection of species and varieties of passion flowers, *Passiflora spp.*; the last include some beautiful red and blue flowering Passifloras, as well as the ordinary edible kinds and the giant granadilla, *Passiflora quadrangularis* L.

Returning to the lake, we pass a collection of indigenous trees, and come to an attractive corner where Aroids have been planted to climb up some of the local forest trees. These include species of *Monstera* and Philodendron, while local lianes add to the attractiveness of the scene.

From here a footpath leads up to the highest point of the Amani plantations, another 700 feet approximately. There are a number of plantations interspersed in the forest on this hill. The first one comes to is a plot of *Cinchona succirubra* Pav., which grows well. Plots of *C. robusta* Howard, *C. hybrida*, and *C. calisaya* Wedd. var. *ledgeriana* Howard are also maintained in this area. *Aleurites fordii* Hemsl. was tried at this slightly higher altitude, but still made only stunted growth, although small quantities of nuts are obtained from time to time. After passing a few trees of *Cupressus*, *Eucalyptus*, and *Acacia* spp., one comes to a mixed plantation of camphor, *Cinnamomum camphora* Nees., *Podocarpus usambarensis* Pilg., and the Cajeput oil tree, *Melaleuca leucadendron* L. Camphor is obtained by steam distillation of the leaves and shoots, wood, or roots of the camphor tree; an essential oil is also obtained. At the corner of this plantation are three tress of one of the Himalayan Maples, *Acer oblongum* Wall., which are growing well and seed regularly. Finally in the last clearing at the top, one passes plots of *Juniperus* and *Cupressus* spp., including *C. funebris* Endl., the funeral cypress, *Cryptomeria japonica* D. Don, the Japanese cedar, and *Widdringtonia whytei* Rendle, the milanji cedar, a handsome conifer from Nyasaland, before gaining the summit. Here also a few specimens of the tree heath have been planted, while on a sheer rock face on the west side the very attractive *Streptocarpus saxorum* Engl. is to be found growing wild. On a clear day, a wonderful view of the surrounding countryside is to be obtained from this spot. Amani lies beneath one to the east, while beyond, through two gaps in the hills, can be seen glimpses of the Indian Ocean. This plantation, at an altitude of approximately 3,700 feet above sea-level, brings us to the end of this rather cursory tour of the Amani Plantations, during which only the more interesting horticultural and economic plants have been mentioned.

Grateful thanks are due to Mr. P. J. Greenway, Systematic Botanist at Amani, for suggestions, and for his painstaking correction and revision of the numerous plant names.

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THE PLACE OF GOATS IN TANGANYIKA FARMING SYSTEMS

(1) IN DECIDUOUS BUSHLAND FORMATION

By H. E. Hornby and H. J. van Rensburg, Veterinary Laboratory, Mpwapwa

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Every farming system is governed by climate; therefore since climax vegetation is the most obvious expression of climate, the division of farming systems into as many groups as there are major formations seems a natural one.

The major formations in Tanganyika are (1) *Evergreen Forest and Mountain Grassland*, where the rainfall is high; (2) *Deciduous Bushland*, where the annual rainfall is below 25 in. and relative humidity is generally low, and (3) an intermediate formation, the true climax vegetation of which is uncertain because recurrent grass fires prevent its achievement; instead one sees a serclimax of numerous *Brachystegia-Isoberlinia Associations* known colloquially as "miombo".

We may say at the outset that we do not think goats have any place in farming systems in areas of mountain forest and grassland. Their place on "miombo" farms has yet to be worked out. It is with the part they can play to advantage in dry bushland areas that we are concerned at present.

Deciduous bushland is a formation of enormous extent, covering all areas which, though both hot and dry, yet have sufficient rainfall (12–25 inches annually) to preserve them from the category of a desert. We are acquainted with it in parts of the Union of South Africa, Southern Rhodesia, Portuguese East Africa, Nyasaland and Northern Rhodesia, as well as in Tanganyika Territory. It also occurs in Kenya as shown by a very recent article of Edwards [1], whose description of the food of goats in a semi-arid area recalls at once similar areas in all the other countries. Most of the species he names, or others closely allied to them, occur in every extensive dry warm area from south of the Limpopo to north of the Tana River. Hornby and Hornby [2] have described in some detail the deciduous bushland associations near Mpwapwa and their article may be consulted by anyone who wishes to know if the vegetation used in the Mpwapwa goat plot experiments resembles that of any area where he, himself advocates, or deprecates, the keeping of goats.

The first part of the Mpwapwa work on goats in relation to bushland was brought to a close with the publication by Staples, Hornby and Hornby [3] of their "Study of the Comparative Effects of Goats and Cattle on a mixed Grass-Bush Pasture". This work demonstrated quite clearly that under the conditions of the grazing experiment the goat's well-known preference for browsing to grazing, Edwards [1], keeps this animal from starting erosion wherever there is a good ground cover which includes bushes. The effect of stocking such land with these animals tended towards the replacement of a two-storey, bush-grass (and herb) community by a single-storey ground cover consisting of many kinds of plants kept at a low level. After four years of heavy but controlled grazing the goat plots were still grassland which, though full of weeds, constituted good grazing for any kind of local stock. There was little bare ground and the cover was too low to support tsetses.

These results showed that no-one need fear that the maintenance of goats in bush country will cause soil erosion either directly through removal of ground herbage, or indirectly through undue competition of goats with cattle for grasses causing the latter to over-graze in consequence. So striking, indeed, was the difference between the appearance of plots browsed by goats and those grazed by cattle that it was obviously desirable to go further, and the then Director of Veterinary Services, Mr. H. J. Lowe, gave every encouragement to an extension of the previous experiment, to ascertain (1) if goats could, with advantage, be introduced into grazing schemes designed primarily for cattle, and (2) if the reduction of bush which, in the small plots was sufficient to check tsetse encroachment, could be achieved on a big scale if a large number of goats were kept.

Experimental Area

This is part of the rather steep hill-side that forms the south side of the Mpwapwa Veterinary Reserve. It has probably been the scene of many successive rotations of thicket and land under Gogo cultivation. These stopped when the Germans took over the valley about 1907.

From then onwards the climax bushland developed with little interference by man until 1934 when some of the land was again cleared by Gogo settlers. By 1938 these settlers had abandoned their clearings, and the Veterinary Department began to turn the area into grassland. The thicket left untouched by the Gogo, as well as that on the land they had partially cleared, was alike cut down and burned towards the end of 1938, and star grass (*Cynodon plectostachyum*) was planted in January, 1939, wherever this double process had produced patches of clean ground. From then until 1934 the mixture of grasses, herbs and regenerating bushes was grazed lightly, and slashed from time to time. As the hill-side was much cut up by gullies, slashing was difficult, and at the start of the experiment the transformation to grassland had not proceeded very far; everywhere the woody vegetation was still much in evidence, and the steep banks of the gullies carried bush, the top of which was well out of reach of both cattle and goats.

Experimental Lay-out

Mr. R. R. Staples was responsible for this and for most of the observations during the first year of the work. The experiment was designed to start at the beginning of 1943 so, during the dry season of the previous year, approximately 30 acres of land were surrounded by jackal-proof wire fencing and this area was then divided by two parallel lines of similar fencing, running up and down the hill, into three plots of approximately 12.6, 12.6 and 4.2 acres, and designated A, B and C. The top fence was placed a few yards above the edge of the clearing, so that each plot had at its top end a fringe of dense climax vegetation.

Plots A and B were then subdivided into halves by a fence of two strands of barbed wire and one of ordinary wire across their middles. This restricted the cattle to either half without interfering with the free passage of goats within their plots, as they passed easily below the bottom strand of ordinary wire.

As in the earlier experiment, and based on some work by Dr. M. H. French, seven native goats were considered for grazing purposes to be the equivalent of one zebu ox. In the earlier experiment, however, no attention was paid to the actual number of grazing days furnished by the plots—all that was wanted was the difference in the effects on the vegetation caused by the feeding of cattle and goats. In this experiment, however, it was hoped that a nearly constant number of animals might be maintained in the plots all the year round. It was proposed that in paddocks A1 and A2 (the two halves into which Plot A was divided) three cows and any offspring they might have should leave their enclosure only once daily for watering and once weekly for dipping; and that the paddocks should be utilized according to a system of rotational grazing. B1 and B2 were to be occupied by two cows and six goats and their offspring. The cattle were to have the same management as those in A, while the goats were to be given the full use of both paddocks all the time. Plot C was to be browsed by six goats and their offspring.

Progress of the Experiment

On 1st January, 1943, three cows and one sucking calf were placed in A2; two cows and one sucking calf were placed in B2, while five nannies and four kids were given the run of both B1 and B2; and one billy, five nannies and three kids were put in C.

This plan was followed for two years and three months, through various vicissitudes of births and deaths; to encourage births, a bull was added to the cattle herds from time to time, and losses due to deaths were made good by appropriate additions. As calves were weaned they were removed. All this entailed closer supervision than an over-worked European staff could afford time for, so in April, 1945, all the female animals were removed and replaced by oxen and castrated goats, and the paddocks were restocked as follows: Plot A by three oxen; Plot B by two oxen and seven goats; and Plot C by seven goats.

At the end of May, 1946, i.e. a little more than a year after this rearrangement, and three years and five months after the start of the experiment, the position was examined carefully and the opinion was formed that the experiment in its original form could now be closed and substituted by a modification of it.

Changes in the Vegetation Between 1st January, 1943, and 31st May, 1946

A table of frequencies of the common plants in the three plots was made at the start of the experiment by Mr. R. R. Staples. It is so similar to the corresponding table given

under the heading "Plants of the Experimental Plots" published in [3] that it need not be reproduced in this article. As in the earlier experiment, the cattle gave most of their attention to the grasses, while the goats almost ignored these. On the other hand, the lower level of stocking in this experiment allowed the goats to pick and choose to a greater extent, and a fair number of plants other than grasses were left nearly or entirely alone. These included *Boerhaavia repens* var. *viscosa, Cassia singueana, Courbonia edulis, Croton dichogamus, Diospyros* sp., *Elaeodendron stuhlmannii, Hippocratea obtusifolia, Lasiosiphon emini, Emilea sagitata, Pergularia extensa, Pteris longifolia, Rhamphicarpa veronicaefolia, Rhinocanthus communis* and *Withania somnifera.* A number of young *Acacia pennata* and *Markhamia acuminata* were, however, ring-barked, an occurrence not noted in the earlier experiment. On the whole the results were of the same nature as those obtained in the earlier experiment, but much less marked. The impressions given by the plots were as follows:—

Plot A (*Cattle*).—Throughout much of the plot the grasses had been nearly eliminated by the combination of grazing, weed growth and thicket re-growth. Only near the cattle pen and on the rich transported soil at the lower end of A2 was the grass cover still satisfactory. The climax thicket at the top of A1 had been left alone.

Plot B (*Cattle and Goats*).—This showed marked differences from A. A large portion remained free from tall thicket and retained a satisfactory grass cover. There were parts, however, where the thicket re-growth was as dense as it was throughout most of Plot A. Similarily, the best ground cover was near the pen and at the lowest part of B2. The climax thicket at the top of B1 was almost untouched.

Plot C (*Goats*).—In general appearance this resembled B. Over almost half the area the bush growth had been kept in check and the grass growth maintained or improved, but elsewhere thicket and woody herbs had encroached on the more valuable ground herbage. The climax thicket had been penetrated and the underpart thinned slightly.

It was evident that although Plot A had maintained three cattle for over more than three years without them causing serious erosion, the time had arrived when the plot could no longer support them adequately, and further exploitation by the animals would cause erosion. Plot B showed a slowing-down of the process of thicket regeneration, and a prolongation of the period when this kind of pasture could be utilized before the cattle began to be both under-nourished and a cause of erosion. Plot C showed no diminution in the total quantity of browse and pasture, and it appeared that goats by themselves could, from the point of view of nutrition alone, be maintained indefinitely at this rate of stocking.

But there are other points of view than that of nutrition. One is disease. The African goat is a hardy animal but by no means immune to diseases. The necessity for housing them every night, and their clustering together by day owing to their fear of lions, leopards, hyænas, jackals and wild-dogs favoured foot-rot, mange and—in spite of their being browsers—strongylosis. Apart from eleven goats killed in one night by lions within a fortnight of the start of the experiment, seven died from disease within 18 months.

Maybe the goats got all the feed they needed at the rate of stocking practised—seven goats to four acres—but the cattle suffered from seasonal under-nourishment when three of them were confined to 12 acres. During some months there was far more herbage than could be consumed, with advantage to the grazing, but towards the end of the dry season there was insufficient feed, and this seasonal inadequacy became more pronounced each year.

Modification of the Experiment

While the results were disappointing to any who thought that the continuous use of goats in reasonable concentration would actually repress thicket and turn bushland into grassland, there still seemed a possibility that the intermittent use of goats in very high concentration might effect these desiderata.

Accordingly, between June, 1946, and May, 1948, a flock of goats that varied in size between 160 and 200 members was rotated, with only short periods of intermission, through the five paddocks. Herd boys had to be employed to see that the animals did not pass the fence of wire strands that separated A1 and B1 from A2 and B2. In addition, during June, 1946, ten cattle were grazed with the goats, and in June, 1947, 60 cattle were similarly used. Altogether during the two-year period the 30 acres furnished 2,270 ox-grazing days and 58,820 goat-grazing days; an average *for each*

acre of 38 ox-grazing days and 980 goat-grazing days *per annum*. These figures are given to show what a high yield of fodder can be furnished by a mixture of bushes, herbs and grasses in a deciduous bushland formation.

From the point of view of the effect of the goats browsing on the vegetation, the result was disappointing in that the final survey after the close of the experiment in June, 1948, showed no halting of the movement of the vegetation towards its bushland climax; only a slowing down of the process. Plot A had at its centre a dense thicket of *Disperma crenatum* seven feet high. Above this was open thicket with a poor ground cover of herbs and grasses which were mainly annuals. The lower part of the plot had a good stand of Star grass mixed with woody herbs and sheltered by regenerating *Acacia spirocarpa* trees 10–15 ft. high. Plots B and C had only small patches of closed thicket. For the most part their vegetation was still a mixture of grasses, herbs and woody shrubs kept to a height of less than five feet. As in Plot A, the lowest part, on rich soil, carried a good stand of Star grass mixed with *Solanum, Achyranthes, Wedelia* and *Acacia spirocarpa*.

The small strip of climax bush that formed the top portion of the three plots had been little touched during the whole period of the experiment. Probably on account of their fear of carnivorous animals, goats seem to be reluctant to enter close cover. This is a good thing, for Staples [4] has shown that when goats are forced into such bush, even moderate browsing of the under parts diminishes the protection the natural vegetation affords the soil. In his experiment there was an almost immediate effect of increasing run-off (2.5 per cent as compared with 0.2 per cent from an unbrowsed plot), although the soil lost from the plot was still less than 0.05 of a ton per acre. In none of our plots was there erosion attributable to the animals.

Discussion

The results of the five-year experiment just described allows us to review the conclusion arrived at from the earlier experiment that "wherever in bushland country there is some sort of ground cover of grasses and herbs which can be expected to extend if given a chance, such an area will not be damaged but may be much improved even by heavy goat browsing, whereas it would certainly be damaged by anything more than the lightest grazing by cattle". The plots of the recent experiment were submitted to heavy goat browsing and to rather more than the "lightest grazing" by cattle. As a result no damage was done to the land by the goats, and inappreciable damage by the cattle. But when we use the word damage in relation to pasture, and think of thicket regeneration as the most serious threat to which unburned pasture in bushland country is exposed, then we find that the browsing of goats slowed down this "damage", whereas the grazing of cattle diminished it hardly or not at all. We think then that the above conclusion can be allowed to stand if we remove the word "much" before "improved", and substitute "probably" for "certainly".

The reply to the question: "Can goats be introduced with advantage into grazing schemes designed primarily for cattle?" is an emphatic "yes" when the farming system is in deciduous bushland formation. There is no doubt that after three years Plot B, which had supported two cattle and seven goats, was in better form to continue their support than Plot A which had maintained three cattle. Unfortunately we do not know what Plot A would have looked like if *in addition to* the three cattle it had had to support seven goats. We shall, therefore, not go to the length of saying that goats do not compete with cattle but rather, that they furnish these with additional grass by removing competing thicket; we say only that in bushland country it is better to keep two cattle and seven goats on a unit of land, than three cattle only.

To the other question: "Can goats be utilized as a practical means of reducing bush to a degree that would check a local tsetse advance?" the answer is "no". The 30 acres furnished nearly 59,000 goat grazing days in two years—equivalent to the maintenance of more than 7,000 goats on a 3,000 acre farm—yet the bushes grew up to a degree that made them habitable for tsetses.

Conclusions

On pastures obtained by clearing bushland, goats can be kept to advantage without fear that they will cause either pasture degeneration or soil erosion. They should not, however, be regarded as bush-clearing agents. When present in reasonable numbers they will slow down the processes of reversion to bushland, but the concentration necessary completely to check the processes is impracticably high.

From the pasture point of view they can be used to greatest advantage where a well-established stand of grasses is being spoiled by increasing numbers of shrubs and woody herbs.

Goats should not be browsed at all on climax bushland that has no ground cover. Not only will they not turn such bushland into grassland, but also they will reduce the value of the bushland's most important function, that of protecting the soil.

In short, goats should be kept mainly for their own value as producers of meat, skins and, rarely, of milk; only secondarily should they be kept to check thicket re-growth, since this is done more efficiently by the use of mattocks and the mowing machine.

ACKNOWLEDGMENTS

We are indebted to Mr. R. R. Staples for starting the extension experiment, to the then Director of Veterinary Services, Mr. H. J. Lowe, for encouraging it, to Mr. C. J. Buckley for supervising it when the Pasture Officer has been away from Mpwapwa, and to the present Director of Veterinary Services, Mr. N. R. Reid, for permission to publish this article.

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REVIEW: WORKING PLANS FOR ESTATE WOODLANDS*

The shipping crisis in 1917 compelled the United Kingdom Government to turn its attention to the home production of timber. The British Forest Commission was therefore formed. Between 1918 and 1939 the Commission's annual planting acreage increased until it was the highest in the world. This interval was, however, too short for the plantations to satisfy to any considerable extent the needs of the second World War and a second devastation of British woodlands took place. Now £40,000,000 is to be spent on timber projects. Part of this will be granted to owners, who dedicate areas for timber production, on condition that a plan of operations is submitted which includes the following:—

(*a*) A schedule of woods to be dedicated and their areas.

(*b*) The work to be done each year in felling, planting and thinning over a suggested period of ten years.

(*c*) The choice of the species to be planted.

The author has set out to compress and simplify the subject of management plans for corporate and private owners of woodlands in Britain. Eighty pages are devoted to the "full plan" and a further ten to shorter and simplified forms of it. The plan follows the accepted scheme and is of general application, but the instances and examples relate to British conditions.

Part I of the report schedule deals comprehensively with the site factors and the composition and conditions of the woods (including volume and increment), while stocking for species and age is illustrated in a map. Past and present systems of management, with yields, receipts and expenses are dealt with next, followed by the legal aspects. Part II, which is the plan proper, divides the area into its working units and describes the method of future treatment. This section deals with such important factors as choice of species, silvicultural system, rotations, general treatment, felling prescriptions, regeneration of areas and subsequent prescriptions. The plan is completed with a financial forecast and a miscellaneous section. There is also a bibliography of about fifty items.

The book will prove extremely useful if it persuades land owners to plan on the model recommended. It is also recommended to estates and agricultural and forest schools which do not wish to incur the expense of a full-scale manual.

L. G. T. W.

* By N. D. G. James, M.C., M.A.: Macmillan and Co., Ltd. Price 6/6.

REVIEW: FIVE HUNDRED VARIETIES OF HERBAGE AND FODDER PLANTS

The Commonwealth Bureau of Pastures and Field Crops, Aberystwyth, has published Bulletin 39, *Five Hundred Varieties of Herbage and Fodder Plants**, which brings together information from specialists in many parts of the world on crop plants used for feeding farm stock.

The crop plants are arranged in an alphabetical sequence according to the botanical name of the plant, together with its common name and a variety name if it has one, all printed in bold type. As examples, *Pennisetum purpureum*: Napier grass. Unnamed, or *Avena sativa*: Spring Oat. Aberystwyth s. 84. Under these names details are given as to the origins of the plants, authority for the information, adaptation, characteristics, resistance (to weather conditions, pests and diseases), use of the strains in various countries, whether certified, authority for certification and finally whether on the open market. For instance, there are four entries for *Oryza sativa*, Rice, each of which has brief particulars about it. *Chloris gayana*, Rhodes grass, has two entries, one from India with twenty lines of information, the other with nearly a page of particulars obtained from this Journal.

The book contains 328 pages, of which 293, the first part, are covered by such notes. The index consists of eighteen pages and is designed to supplement the notes, and at the same time refers to published information on crop varieties compiled from volumes 1–17 of *Herbage Abstracts* published by the Commonwealth Bureau, Aberystwyth. The remaining ten pages are restricted to the advertisements of seed growers and merchants, one of whom is enterprising enough to publish particulars of his business in five languages.

The book can best be described as an address book of crop plants suitable for the feeding of farm stock. It should be of value to those who are raising stock and who have to provide pasture and fodder for their cattle, or if they are on the look out for new herbage and fodder plants for trial, as the book gives this information, and if and where planting material of such plants can be obtained.

As the editor points out, the collated information reveals the need for a completion of the data by the inclusion of entries from other countries. This is apparent when one considers that of the 500 plants listed, the Oat, *Avena sativa*, is represented by fifty-two entries, while such East African plants as Kikuyu Grass, *Pennisetum clandestinum*, Mkoka Grass, *Panicum trichocladum* and the much publicized Groundnut, *Arachis hypogæa*, are not represented at all.

The editor also stresses the desirability of some attempt being made by research workers to achieve uniformity in regard to standards, nomenclature, synonyms, etc. With this very laudable aim I agree and a start could have very well been made by the Bureau with regard to the botanical nomenclature of the first five hundred. For instance, pp. 8–16 are taken up by *Andropogon sorghum*, whose accepted botanical name is *Sorghum vulgare* Pers., while pp. 226–230 contain nine references to *Sorghum* spp. in their rightful place. Then there are entries for plants whose specific identities have not been established at all, there are three in *Sorghum* alone. If they cannot be identified specifically, why include them in a book of this nature? Under *Eleusine* sp., from Lake Naivasha, grown in and reported from India, the editor appears doubtful about its correct identity and says, "for remaining details *see* notes for *Cynodon plectostachyum*". This *Eleusine* might even be *Chloris gayana*, Rhodes grass, but certainly not the so-called *Chloris gayana* on p. 102, whose inflorescence is described as "a one-sided spike".

Some uniformity could have been achieved where the botanical nomenclature is concerned, by consulting the authority on such matters, the Royal Botanic Gardens, Kew, where they have a staff of plant taxonomists who deal with such problems. Whether uniformity will ever be achieved with variety names, especially where the profit interest comes into the picture, is a different matter entirely.

P. J. G.

* *Five Hundred Varieties of Herbage and Fodder Plants*, Bulletin No. 39 (1948), pp. 1–8 and 1–328. Price: Sh. 15; Commonwealth Bureau of Pastures and Field Crops, Aberystwyth.

KERDA

By M. Lunan, Agricultural Officer, Tanganyika

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Kerda is a Gujarati word used in East Africa for the unripe fruit of *Capparis elæagnoides* Gilg. There is a small but profitable export of *kerda* from several places in the Lake and Western Provinces of Tanganyika, especially from the station of Seke in Shinyanga District.

Capparis elæagnoides is a straggling bush with green stems, small leathery leaves, and paired recurved thorns, the thorns of each pair lying at an angle of about 120° to each other. It is common in the "cultivation steppe" of Usukuma and north Unyamwezi, and is known, with allied species, by the local Kisukuma name *Lubisu*. In August and September these bushes bear numerous unripe green fruits the size of large peas. These are gathered by children as they wander around looking after their herds and are sold to the local Indian shopkeepers. The price varies from 20 cents to 50 cents for a 4-gallon tin of fruit.

The Indian women remove overripe fruit, fruit of other species, stalks and other impurities and then steep the *kerda* in brine, with perhaps lemon juice and turmeric added, for fifteen to twenty days. This process removes the bitter taste of the unripe fruit and the resultant product has a pleasant pungent taste. *Kerda* is railed from Seke, preserved in brine in 4-gallon tins, to Indians throughout East Africa. There is heavy demand in Kenya and Uganda, where it is said to fetch Sh. 15 for a 4-gallon tin. The amount exported from Seke is very variable; the railway returns show 8,475 kilos in 1944, 60 kilos in 1945, 1,050 kilos in 1946 and 234 kilos in 1947. The Indian consumers use *kerda* in many ways, mainly in pickles and chutneys, but it can be eaten alone flavoured with oils and pepper. The local Africans do not eat the fruit of *Lubisu* or any of the other *Capparis* species.

The genus *Capparis* is used in various ways, but is of little commercial value. The "capers" of caper sauce are the unopened flower-buds of *Capparis spinosa* which grows wild in Greece and North Africa and is cultivated in some parts of Southern Europe. Capers are imported into Britain pickled in vinegar and salt.

It is in India that *Capparis* is most fully exploited and a study of the literature reveals an astonishing number of uses. The unripe fruit of several species is treated as *kerda* and used in pickles and chutneys. (*C. spinosa, C. Zeylanica, C. aphylla, C. horrida*), or the ripe fruits may be eaten fresh (*C. spinosa* and *C. aphylla*). The flower-buds of *C. aphylla* and *C. spinosa* are used as capers, and the leaves of *C. spinosa* as a pot-herb. Several species yield oil used in lamps and as a medicine, and the wood of other species is used for making small objects where resistance to termites is important. Medicinally, *Capparis* is used in India for many ills, though I doubt whether many of these uses have the support of a modern pharmacopœia. The astringent properties of most of the species are widely used in the treatment of ulcers and skin infections. The counter-irritant effect is useful for boils, rheumatism, and other inflammatory swellings, and young shoots and leaves are powdered to make a blistering agent. The bark of *C. horrida* is used in the treatment of cholera and a decoction of the leaves for syphilis. The bark of *C. spinosa* has a diuretic effect and is used to treat dropsy, gout and rheumatism. Buds and young leaves are eaten to prevent scurvy. In East Africa, *C. elæagnoides* is reputed to be useful in relieving asthma and is given to women before childbirth.

I am grateful to Mr. P. J. Greenway for confirming the identification of *Lubisu* and to the Department of Agriculture, Dar es Salaam, for obtaining the information about *Capparis* in India.

[*Note.*—Besides the Lake and Western Provinces, *C. elæagnoides* Gilg. has been recorded from the northern parts of the Central Province of Tanganyika. Other localities in which it is found are a number in Uganda including the Sesse Islands. In Kenya, at Ngong and the Northern Chepalungu Forest of Sotik. In Ethiopia on the plateau east of Harar. Fifty-seven species of *Capparis* are recorded in Africa, amongst these there are eight in East Africa which have similar native uses to those described for the Indian species. There are also three species in East Africa recorded as poisonous, *Capparis lilacina* Gilg. (roots), *C. persicifolia* A. Rich. (bark) and *C. tomentosa* Lam. (fruits and roots), the last-named is widespread throughout tropical Africa; *G. elæagnoides* is not however closely related to any of these three. P. J. Greenway, Systematic Botanist, Amani.]

COTTON GINNING IN TANGANYIKA AND COMMENTS THEREON

By R. I. Butler, Agricultural Officer and Ginnery Inspector, Tanganyika

(*Received for publication on 1st September*, 1948)

Ginning is the first process which cotton undergoes after removal from the plant, and it separates the cotton or "lint" (as it is called) from the seed. This operation should damage the seed and lint as little as possible.

Ginneries are the factories in which the cotton is cleaned, ginned and baled by the seed cotton openers, gins and presses. A brief description of each machine and its functions will be given in order of progress through the ginnery.

Seed Cotton Openers

When the seed cotton arrives at a ginnery it has usually been subjected to tight packing in bags, also it has gathered dirt such as sand and dust at various places since leaving the plant. A machine known as a seed cotton opener is used to open the fibres and straighten them out, to assist the gin roller and knife to catch hold of the fibres quickly, and to clean the seed cotton of extraneous matter. This machine consists of a cast iron frame in which are housed feed and delivery lattices and two cast iron cylinders of 16 in. diam. x 50 in. wide, on which are fixed mild steel taper pegs of about two-inch length. These pegs number 500 on each cylinder and are set at three-inch intervals. These two cylinders revolve in the same direction at approximately 530 r.p.m. The seed cotton is fed by one of the moving lattices into the two spiked cylinders which by their rotary movements tease out the seed cotton fibres and at the same time give a shaking action to the seed cotton, thus loosening the sand, dust and trash.

On top of the cylinder casing in which the cylinders rotate, and connected by a flue, is a spider fan which rotates at 1,200–1,400 r.p.m. When a downdraught type seed cotton opener is employed the fan is placed underneath the cylinders and draws the dust and sand, etc., down. This is usually more efficient than the up-draught type, owing to the assistance of gravity. The fan current draws off the light sand, dust and trash (as the seed cotton is being treated by the opener cylinders) and deposits them outside the building into a box or chamber, the heavy material falling through the bottom grid casing on to the floor beneath the cylinders. This extraneous matter should be cleared away, approximately twice every twelve hours, or more frequently in the case of very dirty seed cotton. The main objects of the machine are:

(*a*) to straighten out the matted and interlaced fibres on the cotton seed. This facilitates ginning by reducing the time the seed cotton is retained in the gin and so lessens the possibility of seed and staple fracture;

(*b*) to clean the cotton seed of foreign matter.

There are two types of seed cotton openers, the 50-in. double cylinder and 40-in. single cylinder. The action of both openers is alike. After passing through the opening process the seed cotton is carried on to the gins by the delivery lattice.

Gins

There are two types of gins. One the "Knife and Roller" and the other the "Saw gin". Various modifications and sizes of these two types are in use. The type in use at present in Tanganyika is the "Knife and Roller". This is a machine with a cast iron frame in which are fitted horizontally a knife or knives, rollers and pusher. These are the main parts necessary for removing the "lint" from the seed. There are three common varieties of the Knife and Roller gins, i.e. Macarthy Single Action Single Roller, Macarthy Double Action Single Roller, and the Middleton Double Roller. The difference between the single action and double action is that the former has one moving knife, and the latter two moving knives. The single action is the most simple and easy to set, a point worth considering if the setting is in the hands of unskilled persons. The double action has less vibration owing to one knife balancing the other, and in Tanganyika has given a slightly higher production of lint per hour. A brief description of the parts and relative operations will be useful to laymen. Inside the frame mentioned is fitted a static or fixed knife, this is a piece of fairly hard sheet steel about 40 in. long with one feather edge pointing downwards. Against this is a roller of the same length

built up on a steel shaft either with leather-chrome washers pressed tightly together so as to form a homogeneous mass, or a roller with a wooden core on which are fastened, annularly, strips of walrus or buffalo hide.

Close to the static knife and roller, inside the machine, are two knives which are reciprocated vertically at a stroke periodicity of 1,200–1,300 per minute at a distance of 1/16th of an inch from the roller and static knife. At the rear, and still close to the moving knives, is a "Seed grid". This consists of forked or slotted metal with gaps about 7/32 in. between the slots or forks. On top of the seed grid is a pusher board the full length of the knives and roller, which is moved to and from the moving knives and roller by eccentrics. The action of ginning is as follows:—Seed cotton is placed on the grid, the "push board" forcing the seed cotton in close proximity to the moving and static knives and the rotating roller. It is then pressed up to the static knife when the cotton hairs or lint pass between the static knife and the roller, and are more or less dragged between them. The moving knives keep pushing the seed cotton upwards thus assisting the removal of the hair or "lint". The lint is carried round by the roller to the outside of the machine, and then taken off the roller by a "doffer", or a corrugated round wooden bar which rotates at 150 r.p.m.

The action of the single action gin is the same, but the moving knife reciprocates at 1,600–1,700 strokes per minute. The usual diameter of a new roller is approximately eight inches. In time the pressure of the static knife wears the roller down, and I have seen rollers on gins reduced to 3½ in. diameter.

This reduction in diameter reduces production, but gives a better ginning action. Obviously the reduced diameter produces a slower peripherical velocity, hence a more gentle tug to the lint hairs. The production per hour in a well set single and double action gin in Tanganyika averages 36–40 lb. of lint.

Regarding the Double Roller Action Middleton Type gin, the order of operation is more or less reversed because the knives are static and the seed grid oscillates. This is roughly the only change involved in the ginning process, although the method of driving is different. The two main advantages of the Middleton type are saving of power and floor space, while only one feeder is required for the two rollers. The production average per hour is 85–90 lb. of lint.

Comparisons between the different makes of gins.—The main difference between the "Knife and Roller" and "Saw gin" is in the action of detaching the "lint" from the seed. As its name implies, the "Saw gin" is made up of a series of circular saws eight inch, ten inch or twelve inch in diameter and may be 40, 70 or 80 in number. The saws are mounted on a shaft contained in a cast iron frame and rotate at approximately 500 to 650 r.p.m. This shaft rotates horizontally, each saw protruding about quarter in. to half in. through what is known as a "Fall Bar Grate". The seed cotton is placed on top of the fall bar grate and the saws remove the lint as it becomes caught up in the teeth of the saws. The "lint" is then carried through the fall bars by the saws and is removed from the full length of the saws by a brush rotating at 1,500 r.p.m. or a blast of air, and is then deposited on to a perforated rotary cylinder. As the cylinder rotates a cast iron callender roller squeezes the lint into the perforations, from where it is cleaned off the cylinder by a knife-edged piece of sheet steel. This process is known as condensing and the machine is called a "Condenser". The foregoing is the main principle of the saw gin.

During the last ten years this type of gin has been much improved upon and the latest model is the 80 saw—12 in. diameter, Air Blast, Murray Patent. With some varieties of seed cotton this machine is capable of producing 800 lb. of lint per hour. The air blast saw gin differs from the brush type mainly in the fact that the stripping of the lint from the saw teeth is effected by a blast of air instead of a brush. On the air blast saw gin there are many refinements and adjustments that are difficult to incorporate on the "40" and "70" saw gin. The saw gin, especially the air blast type, is more economical in power consumption, takes up less floor space, and requires far less labour in attendance, production for production, than the knife and roller gin.

The main reason for the general use in East Africa of the knife and roller gin is that it removes the lint from the seed with a minimum of damage, resulting from neglect and unskilled setting which is less difficult with this type than with the saw gin. Another reason is that when cotton production started in East Africa the type of saw gin then being manufactured was somewhat crude. The advent of the air blast saw gin has, in my opinion, placed the saw gin to the fore, in that it provides for such a wide range of adjustments that it can be so set as to remove the lint from the seed

as gently as the knife and roller gin with a slight reduction in the maximum production of the air blast gin. A further advantage of the air blast saw gin is that each gin contains integrally a seed cotton opener and cleaning apparatus, which require no additional labour as is the case with a seed cotton opener attached to ginneries where the knife roller gin is operated.

"Seventy" and "eighty" saw gins contain automatic feeding which is continuous, with pneumatic conveyance of the lint to the press, thus effecting a further economy in labour as well as keeping the lint clean. I think that the prejudice against saw gins can be safely abandoned, but the change over to saw gins would be more or less financially out of the question at present for ginneries equipped with knife and roller gins. It would be a good idea, however, for new ginneries to instal at least one air blast saw gin for trial.

Presses

After the lint has been successfully removed from the seed it is carried by hand to a baling press. This machine condenses the lint by pressure into a bale of regular shape. A standard bale weighs 400 lb. net, with a density of 28 lb. per cub. ft. The standard hydraulic bale press is roughly a cylinder 12 ft. long with a piston of about the same length and 10 in. to 12 in. diameter. These are let into the ground and above them is a stationary or mobile box of steel plates into which the lint is put. After 400 lb. of lint have been placed into the box and the box top closed with a strong plate, the piston (which has a table on top that fits into the box size) is pushed upwards by hydraulic pressure. This can exert just over 4,000 lb. pressure per square inch. As the piston ascends the pressure on the gauge (which is placed close to the press box) increases as the bulk decreases.

When 2,000 lb. per square inch is registered on the gauge the pressure ram is stopped and the box removed. The removal of the box at this stage is very necessary, as under a higher pressure it would be almost impossible to move it. Hoops, in the ends of which are elongated holes, are then placed round the bale. When the ends overlap and the holes coincide studs with elongated heads are put through both holes and turned round. The pressure is then released and the piston lowered to any level desired to take off the bale. The hoops are approximately 90 in. long by 1 in. wide and are made of 20 gauge and 40 tons tensile steel.

In some countries where the natural humidity is low the lint has to be artificially humidified before enough lint to make a 400 lb. bale can be put into the baling box. Where humidity is low the cotton is too springy to get the correct weight into the baling box. The amount of water taken up by lint in the humidifying process is 4–6 lb. per bale. Bales pressed under natural atmospheric conditions take up in the passage to India or England 3–6 lb. of free moisture.

Bales are wrapped in hessian which is put on prior to baling and hooping. After completion of baling the bales are marked with the name of ginnery of origin, the weight, the quality, lot numbers and serial numbers. When the cotton is sold forward the buyer's marks are also put on the bales.

There are two other types of baling presses in use, the cantilever (Bi-Jou) and the screw type press. These presses produce a bale of 200 lb. with a density of 14 lb. to the cubic foot; very few are now in use in Tanganyika.

Comments

One of the most important points to watch in any ginnery building and one which has been sadly ignored in the past is the matter of ventilation or dust extraction. "Roof Apex Ventilation", depending chiefly on convection currents, is now installed in all the Tanganyika ginneries. Temperature and humidity also are two important factors affecting ginning production. It has been observed that the night-shift at ginneries usually turns out more pounds per hour than the day-shift because of the higher humidity and lower temperature experienced during the night period.

Cotton ginning difficulties result from various causes including careless picking and sorting, bad handling either during buying, transport to ginneries, or during the ginning process. Pests and diseases do not really come into the picture in this article, but one pest, "stainers" (*Dysdercus* sp.), is of importance to the ginner. These insects are usually found around ginneries and stores. It is quite easy to eradicate them by burning them with a blow lamp in the morning when they are sluggish. This also kills the nymphs and eggs. These insects do a considerable amount of damage to the cotton, so, by destroying them at the ginneries whilst they are swarming before flight, a good service is done.

In connexion with bad handling, the following are points to watch. Firstly, the seed

cotton when purchased should be stored loose. Afterwards it is put into gunny bags for ease of transport to the ginnery, and for storing at the ginnery. It is in the method of bagging that damage is done, by the bagger ramming the seed cotton tightly with sticks which are usually pointed. The point of the stick tends to fracture the lint staple and may also damage the seed. Bagging machines would eliminate this danger as well as speed up bagging.

Secondly, the seed cotton opener, unless well maintained, can damage the lint and seed. On the seed cotton opener as described above, are two cylinders on which are mounted steel pegs in line with the radius of the shaft. After some time these pegs become bent and jagged. The pegs strike the seed cotton at 2,200 feet per minute, and if the pegs are sharp or jagged then it is obvious that some damage will be sustained by the seed or lint resulting in a loss of both. Continuous attention, especially in cleaning out dust, etc., from underneath the opener, is most essential. Thirdly, damage can occur in the ginning. Here the main points to watch are eccentric rolls, mutilated rolls and bad knife edges. Cracked seed is usually the result of any of the aforesaid faults.

Mechanization

In my opinion, the time has now arrived for as much mechanization as possible at ginneries. At present seed cotton is transported from the seed cotton opener to the gin by hand, gins are hand fed, and lint is taken to the press by hand. Pneumatic transport of seed cotton to gins, mechanical feed to gins, pneumatic transport of lint to press, mechanical and one point delivery of cotton seed should be adopted. The advantages of pneumatic transport of seed cotton to gins are the saving of labour, and the elimination of large quantities of seed cotton in proximity to gins. Mechanical automatic feed to gins increases output per hour in that as the feed is constant and uniform along the whole length of the gin knife or knives. Pneumatic transport of lint to press also saves labour and time and keeps the lint clean. Labour is getting more and more difficult, and even when obtainable it is erratic, as the labourers take one and a half to two months to fill a monthly labour card, thus necessitating 30 per cent more labour to be enrolled than is actually required. Under the usual arrangement cotton seed falls below each gin on to the floor and is bagged underneath the gin by hand, but in one or two ginneries the seed falls down a chute below each gin directly into a bag. These bags invariably overflow, so that in the case of seed fed in this way a large amount has to be collected or put into the bags as a result of failure of attendants to remove filled bags and replace with empties. A single point delivery of cotton seed saves labour, and the seed can be weighed at the point of delivery so that a constant check can be kept on cotton seed weight. The foregoing ideas are already in operation in other cotton growing areas of the world.

NOTES ON ANIMAL DISEASES

XXI—DISEASES CAUSED BY WORMS—(PART II)

Compiled by the Veterinary Department, Kabete, Kenya

(Received for publication on 14th September, 1948)

Roundworms

The roundworms have a smooth skin and an alimentary tract. The sexes are separate and all the larger forms are parasitic. The class is a large one and is divided into five orders, only four of which need be mentioned here. These are the Ascaroidea, Strongyloidea, Filaroidea and Trichinelloidea.

Roundworms of Horses.—There are two members of the Ascaroidea and a large number of strongyles found in equines in East Africa. All of these have a direct life history. Of somewhat less importance are members of the genus *Habronema* (Filaroidea).

Ascaris equorum are large, cylindrical, white or yellowish worms tapering to each end. The males measure up to ten inches in length and the females up to fifteen. They are often present in enormous numbers in foals. The best treatment consists in the administration of carbon bisulphide in capsule. Turpentine and linseed oil—one to four ounces turpentine in one pint linseed oil—is also of value. The other important member of the family is *Oxyuris equi*, the pinworm, which lives in the large intestine. These worms are white and cylindrical, the females having a tail very variable in length. The males are about half inch long and the females measure up to six inches. The available methods of treatment are not wholly satisfactory. The old-fashioned treatment was a strong infusion of quassia chips used as an enema. Oil of chenopodium in a purgative dose of linseed oil is also used.

Of the strongyles there are four members of the genus *Strongylus*, greyish-brown worms, the females of the largest species being a little less than two inches in length. The adult worms live in the first part of the large intestine, but during their early stages the worms migrate by way of the abdominal organs and blood vessels. One species, in particular, *S. vulgaris*, is the cause of blockage in the mesenteric arteries, which, if severe, produces a form of colic. Before actually entering the gut the larvæ spend about a month in nodules in its wall.

In addition there are a number of smaller strongyles, members of the genus *Trichonema* and others which are usually known as "red worms". They can be seen moving in the droppings of severely affected animals. The adults live in the large intestine and the larvæ occur in nodules in the wall of the gut.

Three drugs can be used for the treatment of strongyles in horses, carbon tetrachloride, oil of chenopodium and phenothiazine. Phenothiazine gives excellent results. This drug is occasionally toxic to horses, especially foals, but accidents following its use are undoubtedly rare and are probably associated with idiosyncrasy.

The three species of *Habronema* are found in the adult stage in the stomach where one, *H. megastoma*, produces tumours in the wall. The eggs in the droppings are swallowed by maggots in which they develop. The mature flies are then responsible for transferring the larval worms back to horses. This may happen when the flies settle on an open wound to imbibe moisture or the larvæ may be deposited on the skin around the mouth. The worms are half an inch to one inch in length and very white in colour; they are not very pathogenic and provided they are not embedded in tumours, treatment with carbon bisulphide or carbon tetrachloride is reasonably efficacious.

Roundworms of Cattle.—In cattle, members of all the orders occur, but in Kenya it is unusual to meet with any species in sufficient quantities to cause disease. A species of *Ascaris* is not infrequently encountered in calves. To the naked eye it resembles that of the horse and treatment with turpentine and linseed oil is usually satisfactory. Of the strongyles, the wireworm and small trichostrongyles are important parasites of calves in Europe and America; but they do not appear to be of much significance in Kenya. They occur in the fourth stomach and early part of the small intestine and when present in large numbers they are responsible for diarrhœa, unthriftiness and anæmia. Wireworm may be controlled by the administration of wireworm remedy at the rate of a No. 5 spoonful per 100 lb. body-weight. Wireworm and some of the small trichostrongyles may also occur in sheep and it is advisable, therefore, not to regard

(*N.B.*—Part I which appeared in the July, 1948, Journal was "received for publication on 31st May, 1948", *not* 1945, as printed.)

land on which cattle have grazed as clean for sheep. Of the other strongyles of the alimentary tract, hookworm have been reported to cause symptoms in calves in Kenya. The species, *Bunostomum phlebotomum*, appears to be restricted to cattle, although it is closely related to that occurring in sheep. The best treatment is phenothiazine at a dose of 20 g. per 100 lb. body-weight to a maximum of 80 g. The common nodular worm of cattle is also distinct from that of sheep and buck; but one less common species occurs in sheep, cattle and goats. Nodular worm in cattle does not appear to produce symptoms.

Lungworms produce "husk" or "hoose" in calves and yearlings in England, and although conditions seem to be unsuitable for the development of heavy infestations, one species is sometimes found in small numbers in the lungs of cattle in Kenya.

Three species of Filaroidea are encountered. Of these, one *Thelazia rhodesii* is sometimes found in large numbers in the conjunctival sac of calves and is best controlled by picking out with a pair of forceps. Another is a *Setaria* which lives in the peritoneal cavity. It is a thin, white worm measuring usually three to four and a half inches in length and does not produce symptoms. The microfilaria sometimes encountered in blood slides from cattle are almost certainly the larvæ of this species, and the parasite is probably spread by sandflies or midges. The third species has not been collected in a condition permitting identification; but is one of the *Onchocerca* group. These parasites produce nodules in the connective tissue of the brisket and are only found in the slaughterhouse. They are more common in cattle in Tanganyika than in Kenya.

Roundworms of Sheep.—The common roundworms of the digestive tract of sheep belong to the orders Ascaroidea, Strongyloidea and Trichinelloidea, but those of the second order only are of economic importance. The small species of *Strongyloides* (Ascaroidea) is uncommon and does not produce symptoms. Species of *Trichuris* or "whipworms" (Trichinelloidea) are often found in the cæcum or blind gut. They are two to three inches long, the greater part of the length consisting of the anterior end which resembles a cotton thread. The short, thicker, posterior portion is more easily seen. The head is attached to the wall of the bowel. These parasites are rarely found in large numbers and appear to do no harm to the host.

The simplest way to discuss the strongyles (Strongyloidea) is to consider them according to the site at which they are found.

In the fourth stomach a number of members of the family Trichostrongylidea or "hair-strongyles" may occur. The commonest species is the wireworm, *Hæmonchus contortus*. This worm is from one-half to an inch and a quarter in length and rather less than one-fiftieth of an inch in maximum thickness. Both males and females are reddish in colour, but the females are thicker and more opaque than the males, and are spirally striped like a barber's pole. The life-cycle is direct. From eggs which are passed in the fæces small larvæ hatch. These feed, grow and moult twice before they become infective larvæ and are ready to infect a new host. When swallowed they pass to the fourth stomach where they cast the sheath of old cuticle which protects the infective stage from desiccation and grow to maturity. The cycle outside the body takes from five to eight days and, after being swallowed, three to four weeks elapse before the females begin egg-laying. About 200 wireworms are commonly sufficient to produce fairly well-marked symptoms in young animals. They are easily seen in the stomach if present in numbers, but the method of collection given at the beginning of this paper should be followed if an accurate picture of the degree of infestation is to be obtained. This parasite is undoubtedly the commonest cause of parasite gastritis in untreated sheep, but is also the easiest to control.

The remaining trichostrongyles are generally referred to as "small trichostrongyles", and with the exception of *Ostertagia circumcincta*, are usually more numerous in the early part of the small intestine than in the fourth stomach. They are all minute, hair-like forms and their presence will be missed unless the small sieve is used. *Ostertagia circumcincta* was almost certainly imported into Kenya with Romney Marsh sheep. In England it is a very pathogenic species in lambs and weaners.

The important parasites of the small intestines are the small trichostrongyles to which reference has already been made and the hookworm, *Bunostomum trigonocephalum*. The small trichostrongyles, known in South Africa as "bank-rot" worms, are members of several genera, the more important being *Trichostrongylus* and *Cooperia*. The life-cycle is similar to that of the wireworm, but its duration, where it has been determined, is a few days less.

FIG. 1.—*Fasciola*—the common liver fluke of sheep and cattle.

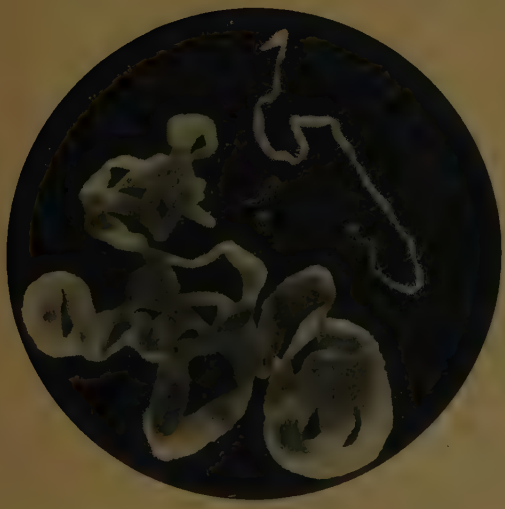


FIG. 2.—*Tapeworms*—three different sized ones to give some idea of the variation in size. These do not include the smallest or the largest.

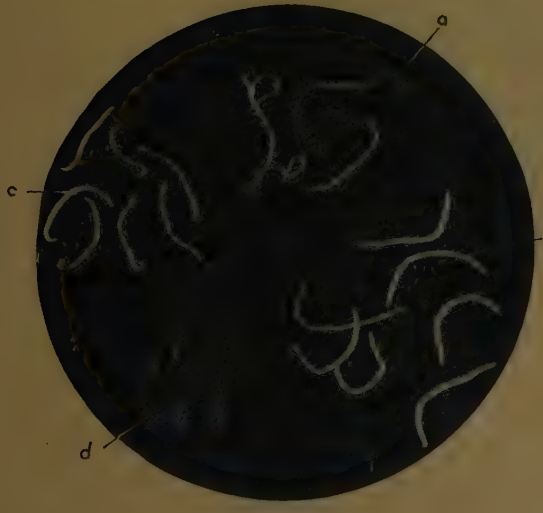


FIG. 3.—*Roundworms of Sheep*—
(*a*) Wireworm.
(*b*) Hookworm.
(*c*) Nodular worm.
(*d*) Small trichostrongyles.

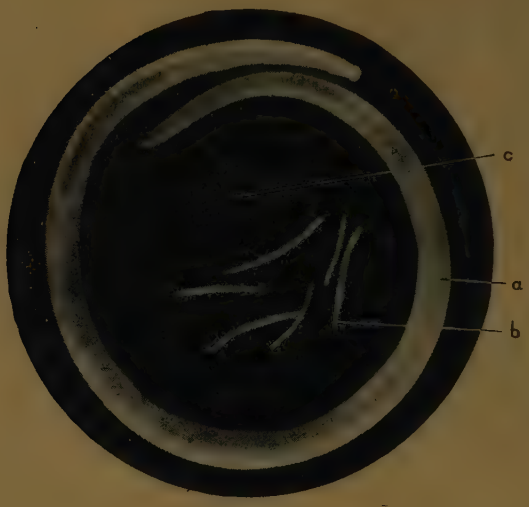


FIG. 4.—*Roundworms of Horses*—

(*a*) Ascarid (the ascarides of pigs are practically identical with this).

(*b*) Strongyles.

(*c*) Strongyles (small) red worms.

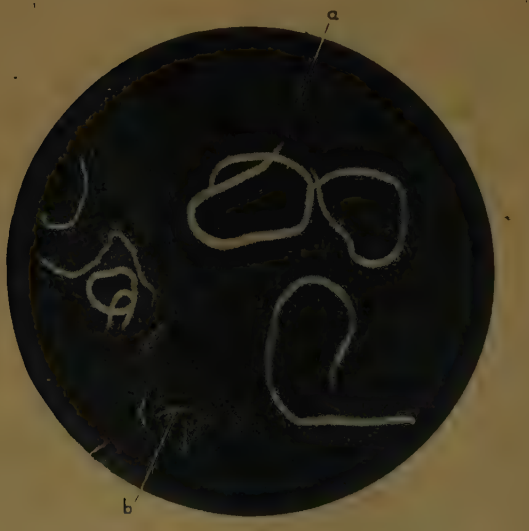


FIG. 5.—*Roundworms of Fowls*—

(*a*) Ascaridia from the small intestine.

(*b*) Caecal worms.

The hookworm is a very important species in the moisture areas of Kenya, for example Molo and the Aberdares; but does not appear to thrive so well in the drier plains country of the Rift Valley and Laikipia. The worms are half an inch to an inch in length, stouter than the other nematodes of sheep and a dirty grey-brown in colour. Whereas small trichostrongyles appear to prefer the first few feet of the small intestine, hookworm may be found in any part of the small gut with the exception of the early part.

The hookworm is probably the most pathogenic species found in sheep in Kenya. About 100 worms are sufficient to produce symptoms in weaners and the pathogenicity is largely attributable to the volume of blood which each parasite consumes in twenty-four hours coupled with the blood lost from hæmorrhage into the bowel at the wounds caused by its bites. If a badly infested gut is opened, the parasites will be found attached in small groups along the bowel wall and covered with brown slime. On removing the worms and washing the gut, its wall will be found speckled with minute hæmorrhages which can often be seen from the outside.

Finally in the large intestine are found the nodular worms. The common species is *Oesophagostomum columbianum.* The worms are slightly smaller than hookworm and can be recognized easily by their bent anterior ends and dead-white colour. Larvæ hatch from eggs passed out in the fæces and after the usual two moults the infective forms develop. These are swallowed by a sheep, lose their sheaths and enter the mucosa of the bowel wall. Here they develop further and within six to seven days moult again. At this stage they are enclosed in a cyst in the bowel wall where they remain for a further six or seven days. They then return to the lumen of the gut, moult again and are young adults.

The larvæ may be overcome by the resistance of the sheep whilst in the cyst and the dead worm in the cyst, or the cyst itself, after the larva has left, may become invaded by bacteria, in which case a small abscess is produced. Later the contents of the cyst may become calcified. The weakness of the gut wall caused by extensive damage is believed to be responsible for telescoping of the gut, when sudden death may occur. This condition is known in South Africa as "reksiekte". The lesions in the bowel wall are referred to as "pimply gut".

In general, however, the symptoms of a heavy nodular worm infestation are emaciation, debility and persistent diarrhœa. The smallest number of parasites necessary to cause symptoms is not known.

Nodular-worm larvæ outside the body are very susceptible to frost, a fact which probably explains the frequency of these parasites in Kenya as compared with England.

The medicinal treatment of strongyles in the alimentary tract of sheep must be based on the species of worms present. The following table shows the value of the various anthelminthics against the different species. The method of use of the drugs is given below.

Species of Worm	Wire-worm	Small Tricho-strongyles	Hook-worm	Nodular worm
Wireworm remedy	++	slight	—	—
Copper sulphate and nicotine ..	++	fair	—	—
Carbon tetrachloride	++	variable	++	—
Tetrachlorethylene emulsion ..	++	fair	?	variable
Nodular worm remedy	++	+	—	+
Phenothiazine ..	++	variable	++	++

Wireworm Remedy and Nodular Worm Remedy are prepared at the Veterinary Laboratory, Kabete, according to the South African formulæ. Full instructions are issued with these remedies, and sets of dosing spoons to ensure the correct dose for animals of different ages can be supplied. The spoons for nodular worm remedy differ in size from those used for wireworm remedy.

Copper Sulphate and Nicotine.—A solution is prepared containing copper sulphate one ounce, 40 per cent nicotine sulphate one ounce in three pints of water.

The dose for lambs is 15–30 cc. according to size and is followed by a dose of castor oil. It should be given two hours before the sheep are let out in the morning. Treatment may be repeated at three-weekly intervals.

Carbon tetrachloride.—Two methods can be used. The first consists in administering one cc. of the drug for 10 lb. body-weight by *stomach tube,* followed immediately by epsom salts. Lambs and weaners should receive one ounce of salts in solution and sheep over twelve months two ounces. This method is recommended when grazing is dry. The other method is to give two cc. of ten per cent copper sulphate followed by one of three mixtures of carbon tetrachloride and liquid paraffin or light grade motor oil.

Lambs and weaners, 20–35 lb.—
3 parts carbon tetrachloride, 7 parts liquid paraffin or oil. Dose: 10 cc.

Weaners, 35–50 lb.—
4½ parts carbon tetrachloride, 5½ parts liquid paraffin or oil. Dose: 10 cc.
Adults—
6 parts carbon tetrachloride, 6 parts liquid paraffin or oil. Dose: 12 cc.

This treatment can usually be employed with safety when the grass is green. With both treatments the sheep should be penned in the afternoon of the day prior to dosing, dosed early in the morning before being allowed food or water, and then released.

Tetrachlorethylene is usually administered as Ortlepp and Mönnig's emulsion. Sufficient emulsion to dose 600 adult sheep is made as follows:—

1 gallon tetrachlorethylene,
1 gallon liquid paraffin,
1½ pints croton oil,
2/3rds gallon water,
2 lb. soft soap.

Dissolve the soft soap in the water in a vessel that can be shaken vigorously and is large enough to hold the final amount of emulsion.

Mix the tetrachlorethylene, liquid paraffin and croton oil in a separate vessel. Add the oily mixture little by little to the soap solution, keeping the solution well shaken.

Although the croton oil tends to separate slightly, the strong emulsion can be kept. Before use it is well shaken, and required amount diluted with half its volume of soft water.

The diluted emulsion is given immediately after a dose of 10 cc. of two per cent copper sulphate solution made by dissolving 2 lb. of copper sulphate in ten gallons of water. The dose of the diluted emulsion is as follows:—

Adult sheep over 12 months	30 cc.
Lambs of 6 to 12 months	22 cc.
Lambs of 3 to 6 months	15 cc.

The remedy must be administered slowly into the side of the mouth, and the mixture should be kept well stirred when in use. Animals must be treated when it is cool, the best time being late in the afternoon. Care should be taken not to chase the sheep about before, during and immediately after treatment. It is recommended that two treatments be given at an interval of fourteen to twenty-one days.

Phenothiazine.—This drug will be of the greatest value to sheep farmers once supplies are available at reasonable cost. The dose recommended is 0.5 g. per lb. body-weight or 10–15 g. for lambs over two months, 20–30 g. for adults. The only difficulty in using this drug is the bulky nature of the dose, but tablets are now produced which can be given as pills. Phenothiazine may also be administered in a lick, and at the rate of one part phenothiazine to fifty parts lick, appears to be successful in controlling worms in lambs or weaners anyway in Rift Valley country.

Roundworms of Pigs.—Although members of all the four important orders of roundworm occur in pigs, the only species of real economic importance in East Africa is *Ascaris lumbricoides.* This species is a large, yellowish-white worm which in the adult stage lives in the small intestine. The eggs which pass out in the fæces are very resistant to desiccation and to the action of disinfectants. After several weeks they mature and, if swallowed by a pig, hatch in the stomach or small intestine. The larvæ penetrate the wall of the gut and travel by the bloodstream to the liver and on to the lungs where they grow and moult twice. After the second moult they escape into the air spaces of the lung and migrate up the windpipe to the throat from where they are swallowed back to the stomach and intestines. Here they moult for the last time and become adults. The time from ingestion of the egg to the appearance of larvæ in the trachea varies from seven to twenty-three days.

Young pigs with a heavy infestation of larvæ in the lungs show the symptom known as "thumps", a name sufficiently explanatory to enable anyone who has seen the condition to recognize it. Large numbers of adults in the gut are responsible for marked unthriftiness. The old treatment was oil of chenopodium, 0.46 cc./10 lb. body-weight up to a maximum of 12 cc. The dose should be given in castor oil (one to two ounces according to the size of the animals) before the pigs are fed in the morning.

Sodium fluoride has now proved to be as good or better than oil of chenopodium. The instructions for the use of sodium fluoride appeared separately in the K.I.O. Fortnightly.

Every effort should be made to rear young pigs as free as possible from these worms. Sows should be treated three to four weeks before farrowing and a day or two before farrowing they should be well scrubbed with soap and water and placed in a clean sty. When the piglets are ten days old they should be moved to a fresh sty or, if possible, to movable huts on clean pasture.

Roundworm of Dogs.—The important roundworms of dogs are the ascarides of puppies and the hookworm. Filarid worms which live in the heart and produce microfilaria in the blood are common in most of the lower parts of Kenya. A related worm, *Spirocerca,* is occasionally found in tumours in the wall of the gullet and stomach, but is rarely diagnosed during life.

The two closely related ascarides, measuring three to eight inches in length, are yellowish-white in colour and live in the small intestine. They are responsible for unthriftiness and, on occasion, fits in puppies. Oil of chenopodium 1 cc. per 22 lb. in castor oil is efficacious.

Ancylostomum caninum is the common hookworm of dogs and is found on rare occasions in human beings. This parasite is related to, but quite distinct from, the hookworms of ruminants. The worms are just under an inch long and live attached to the wall of the small intestine.

Hookworm infestations should be treated with carbon tetrachloride in capsules, the dose being 1 cc. per 10 lb. body-weight to a maximum of 5 cc. followed by a dose of liquid paraffin or epsom salts.

Roundworms of Poultry.—A considerable number of species of roundworms are found in poultry, all the four orders being represented in East African birds. In Kenya the members of the Ascaroidea are by far the most important. They are *Ascaridia galli* found in the small intestine of fowls and turkeys, and species of the genera *Heterakis* and *Subulura* found in the cæca and rectum. *Ascaridia galli* are fleshy, white worms, the males being one to three inches and the females two to almost five inches in length. The cæcal worms are about half inch in length, but easily seen when present in quantity or when the contents of the cæca are washed. The life-cycle is direct and both types may be the cause of wasting and anæmia in poultry. Nicotine sulphate or phenothiazine are the usual remedies. One teaspoonful of seven per cent nicotine tobacco extract is *well mixed* in three pints of mash. Mash so treated is fed for several days in succession. Phenothiazine is given at the rate of 0.5 g. per bird. This may be given in the mash but is better given individually to the birds. After treatment the birds should be moved to clean ground.

Of the Strongyloidea, the gape worm, *Syngamus trachea*, has been recorded from Uganda, and we have heard of its occurrence in Kenya. These blood-sucking worms are red in colour and live in the trachea of poultry. The females are from half to nearly two inches in length and the much smaller male remains permanently coupled so that the pair are like a letter "Y", both heads being attached to the mucous membrane. This species may be spread by wild passerine birds and it would appear that earthworms may serve as intermediate hosts, although an intermediate host is not essential.

The latest treatment in America is to expose the birds to a dust of barium antimonyl tartrate. The birds are placed in a box with about six inches headroom and one-third of the dose of powder is blown in with a dust-gun at five minute intervals. The box is rocked occasionally to cause the birds to flutter, thus keeping the dust agitated and the birds panting. For a box of eight cubic feet capacity a total of one ounce of the powder should be used. Until recently the best method of treatment was removal with a fine wire bent into a corkscrew spiral.

Of the Filaroidea the commonest representative is *Tropisurus*, the red females of which live in the glands of the proventriculus of all species of domestic poultry. The life-cycle is indirect and they do not appear to be of much importance. Another species is *Gongylonema ingluvicola*, a long, rather robust worm, which is sometimes present in enormous numbers in the crop of fowls. The larvæ develop in insects.

Finally of the Trichinelloidea we have species of *Capillaria*. These are very fine worms and have never been found in numbers in Kenya. In other countries they have been known to cause severe outbreaks of disease in young birds.

Ringed Worms

The only ringed worm parasites of the domesticated animals are the leeches. These animals are found in sluggish rivers, dams and lakes. The skin is built up of rings and there is a sucker at each extremity. Leeches are markedly contractile and progress by "looping". They live on blood, attaching themselves to the bare areas of skin around the lips, nose and eyes and in the nose, mouth and throat of animals when drinking. On the external parts they soon become detached, but leeches often remain attached in the mouth, pharynx or nasal passages when they may cause difficulty in breathing and in swallowing. The presence of these parasites may be indicated by blood-stained froth around the mouth or nostrils or by stertorous breathing.

Leeches which can be reached may be removed by gripping them with the hand wrapped in a dry cloth or with a pair of toothed forceps. For those in the nose or pharynx a couple of ounces of a warm solution of salt, vinegar or chloroform may be injected into the nose or back of the throat with a piece of thin rubber tubing attached to a syringe. Leeches in dams may be killed by the addition of copper sulphate to the same concentration as is required to kill snails.

THE UGANDA SOCIETY

The Uganda Society was founded at Entebbe in 1923, and was originally called the Uganda Literary and Scientific Society. In the beginning it was almost entirely a lecture society but after five years' interest failed.

In 1933 the Society was revived under its present title and has steadily gone forward. It was the first society in East Africa to open its doors to peoples of all races for free discussion and to-day occupies a unique position in the Protectorate by virtue of its tolerant attitude towards current problems, and a sincere desire to be of service to the community. Lectures were resumed in September, 1933, the first number of the Society's publication, the *Uganda Journal*, appeared in January, 1934, and a room for use as headquarters was acquired in Kampala in 1939. Further accommodation, including a writing and reading room (which houses the library), a lecture room, and offices have since been added. The membership of the Society is now nearly eight hundred, and is still growing.

The Uganda Society aims at promoting interest in literary, historical, scientific and general cultural matters among individuals of all races and callings in the Protectorate; discovering and placing on record facts and information about the country and its peoples; acquiring books on Africa generally, but especially books of all kinds relating to Uganda, to be maintained in a reference library in Kampala for the use of members and visitors; arranging lectures from time to time on any subject of interest, and establishing contacts between members.

The Society desires also to co-operate with other institutions in the pooling of collected information on matters and problems of common interest, and seeks to help research students and others interested both in the scientific and cultural life of Uganda.

The library contains over 16,000 books and periodicals chiefly on subjects connected with East Africa, and also a large number of English, local and vernacular newspapers, magazines and reviews. It includes most of the standard books on Uganda and East Africa, dealing with history, travel, exploration, sport, language, ethnology, natural science, as well as Government Departmental Reports, Parliamentary Papers, etc., and is continually expanding. The Society owns a valuable collection of early maps of the Protectorate, as well as sets of the up-to-date surveys of the country.

The *Uganda Journal*, issued by the Society half-yearly, is published in March and September by the Oxford University Press. Back numbers of most issues of the Journal and of other publications of the Society can be supplied as advertised on the back cover of the current issue. Material offered for publication in the Journal should be sent to the Honorary Editor at the Society's address. Contributions in the form of short notes and records, as well as longer articles, are invited. Authors receive twenty separate copies of their contributions free of charge; additional separates may be obtained at a cost of ten cents a page if ordered at the time when the manuscript is submitted. The Editor can usually arrange for manuscripts to be typed.

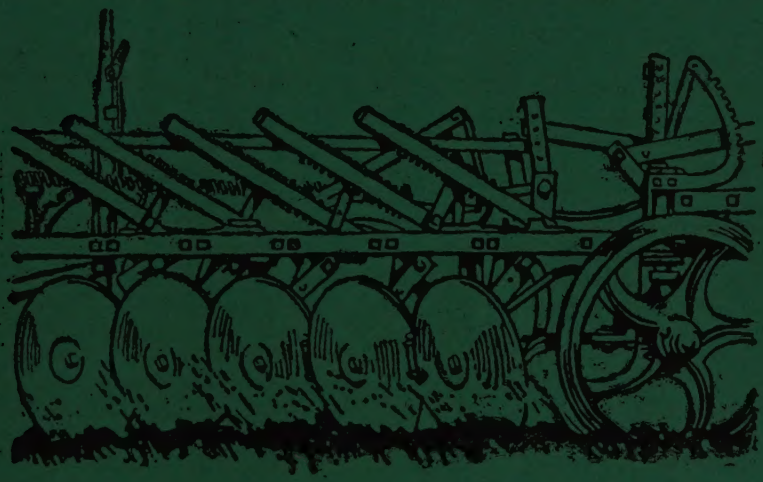
Publication of the Journal was suspended between 1941 and 1945 owing to the war, but even during this period occasional printed bulletins appeared. They were re-issued as a separate number of the Journal when publication was resumed in 1946.

Circulation of the Journal is not confined to East Africa, and there has been an increasing demand for it abroad, particularly in Europe, South Africa and America, both by learned bodies and private subscribers.

The Society also sponsors other publications from time to time. It was responsible for Captain C. R. S. Pitman's "'A Guide to the Snakes of Uganda", which was very favourably reviewed, and which earned for the Society, as well as its author, the congratulations of the Imperial Government; and Sir Albert Cook's "Uganda Memories", which likewise had an enthusiastic reception and was quickly sold out. A third book, a translation of Pere Gorju's scarce "Entre le Victoria, l'Albert et l'Edouard", is expected to be in the hands of the printers shortly.

Membership of the Society is open to persons of all races, without distinction of class, creed, sex or colour, and to institutions (libraries, schools, clubs, hotels and business or departmental offices) as well as to individual subscribers. No entrance fee is imposed.

The Society's postal address is: The Uganda Society, Private Bag, Kampala.



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